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ABSTRACT

This report, together with volume I (single degree programs), detail 105 post-secondary wastewater treatment programs from 33 states. These programs represent a sample, only, of the various programs available nationwide. Enrollment and graduate statistics are presented. The total number of faculty involved in all the programs surveyed was 1,106; full-time faculty comprised 73 percent of this. Curricula, sources of research funds, and student financial support are presented, and a wastewater employment profile is given. (BB)

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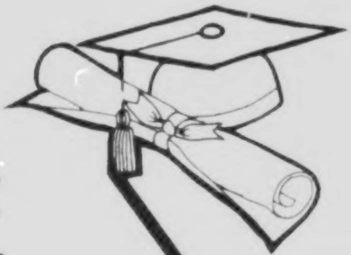

Post Secondary Education Profile

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WASTEWATER II

(Multiple Degree Programs)

Phase II

Of A National Environmental/Energy Workforce Assessment

Conducted by:

NATIONAL FIELD RESEARCH CENTER, INC.
P. O. Box 287
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SE 025 210

NATIONAL ENVIRONMENTAL/ENERGY WORKFORCE ASSESSMENT

PHASE II

POST-SECONDARY EDUCATION PROFILE

WASTEWATER

VOLUME II

(Multiple Degree Programs)

Conducted by:

NATIONAL FIELD RESEARCH CENTER, INC.

Under Grant from:

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INTRODUCTORY NOTE

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Sincere appreciation is expressed to those persons within the United States Environmental Protection Agency, Office of Federal Activities, who provided guidance and direction throughout the term of the project: Mr. J. Donald Cook, Project officer; Mr. Joseph McCabe, and Mr. Michael Moore.

A special word of thanks is extended to the following individuals: Mr. Elmer M. Chenault, U.S. EPA Region VIII; Mr. James Hindman, Clemson University; Mr. Robert Knox, U.S. EPA Region II; Dr. Floyd C. Larson, University of Tennessee; Mr. Robert Roth, U.S. EPA Region IV; Mr. Tahlman Krumm, Ohio State University; and, Dr. James Suddreth, Water Pollution Control Federation.

Gratitude must be expressed to the many individuals and organizations from the private sector who were most generous in their contribution to this project. Their openness and responsiveness reflect their concern regarding the training of our environmental workforce and their critical role in that effort.

REVIEW COMMITTEE

A special word of acknowledgement is extended to the following people who graciously gave of their time, knowledge and experience in order to review and comment on the information included in this volume. The efforts of this national committee were particularly insightful, and in general have been incorporated into the final report.

It must be pointed out that in all cases the individuals acknowledged below were asked only to review and comment on the material contained in the volume and to express their views regarding the representativeness of the material presented. They were not asked to endorse either the volume or the study in general, and the inclusion of their name on this list should not be considered an endorsement since such was not the intent.

In light of numerous responsibilities, it is especially important to note that these persons responded within very strict time constraints. Such a pattern reflects positively on both the individuals and the institutions and organizations which they represent.

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FOREWORD

Information for this report was largely compiled from on-site interviews with professionals in post-secondary institutions throughout the United States. On-site interviews were supplemented by telephone and/or mail contact to clarify and revalidate the data. This report presents a summary of programs in junior colleges, vocational/technical training institutes, community colleges, four-year colleges, and universities as well as other training institutions. Programs are representative of all levels from academic certification through doctoral degrees. The environmental pollution control areas of air, noise, pesticides, potable water, radiation, solid waste, wastewater and energy were surveyed.

This study was conducted for the United States Environmental Protection Agency by the National Field Research Center, Inc. of Iowa City, Iowa, with field offices located in Atlanta, Georgia; Denver, Colorado; and Washington, D.C.

NATIONAL ENVIRONMENTAL/ENERGY WORKFORCE ASSESSMENT

PHASE II

POST-SECONDARY EDUCATION PROFILE

WASTEWATER
SUMMARY

THE FOLLOWING PAGES PRESENT AN OVERVIEW, IN SUMMARY FORM, OF BOTH VOLUMES OF THE WASTEWATER REPORT. WHILE THE SUMMARY SYNOPSIZES THIS ENVIRONMENTAL AREA, INTERESTED READERS ARE ENCOURAGED TO REFER TO BOTH WASTEWATER VOLUME I AND WASTEWATER VOLUME II FOR A MORE IN-DEPTH PRESENTATION.

WASTEWATER

A. States, Institutions, Programs and Degrees

The two wastewater volumes (Wastewater Volume I and Wastewater Volume II) detail 105 postsecondary programs from 33 states. There are 88 institutions represented in the two volumes. The environmental programs included in the volumes, range from operator training at the local level to advanced degree programs offered within the universities. The reader is advised that the report was presented in two volumes due to the extensive number of programs summaries included in the environmental area of wastewater. Wastewater Volume I contains all single degree programs, the majority of which are associate and masters degrees. These degrees make-up 66% of the programs included in this volume.

The multiple degree programs are presented in Wastewater Volume II and are represented as: bachelors, masters, and doctoral degrees; and masters and doctoral degrees.

WASTEWATER PROGRAM DEGREE OFFERINGS

Program Degree Offerings	Percent Represented In Wastewater Volumes
Certificate	10%
Diploma	2%
Associate Degree	18%
Certificate, Diploma and Associate Degree*	4%
Associate and Bachelors Degree*	3%
Bachelors Degrees	5%
Masters Degrees	12%
Bachelors and Masters Degrees*	9%
Bachelors, Masters and and Doctoral Degrees*	12%
Environmental Engineering Degree	1%
Masters, Environmental Engineer, and Doctoral Degrees*	24%

*Multiple degree programs

The above table reflects the two volumes and the types of degrees offered by the participating institutions.

B. Enrollment Statistics and Graduates

The table below summarizes enrollment figures from all of the participating institutions in the two wastewater volumes.

WASTEWATER ENROLLMENT PROFILE SUMMARY

Degree	Enrollment Full-Time/Part-Time		Average # Per Year	Graduate Enrollment Change By Program Up / Down / Stable		
Certificate	229	1,168	236	1	0	5
Diploma	111	3	58	0	0	4
Associate[1]	541	70	14	7	2	11
Bachelors[2]	2,163	67	44	11	3	13
Masters	1,257	714	25	23	6	29
Env. Eng.	3	0	2	0	0	1
Doctoral[3]	271	14	3	7	2	18
TOTAL	4,575	2,036	382	49	13	81

[1] Does not include Miami-Dade Community College for which figures were unavailable.

[2] Does not include Illinois Institute of Technology and University of Rhode Island for which figures were unavailable.

[3] Does not include Rutgers University, Renssalear Polytechnic Institute and University of Rhode Island for which figures were unavailable.

Full-time enrollment in the certificate programs ranges from four to 185. However, only one of these programs has a full-time enrollment of 185 while the remainder report from four to 40 students. Approximately 46% of the programs indicate zero full-time students and 8% were unable to supply the information. Overall, only 13% of the total students enrolled in certificate programs are full-time, while 87% are part-time. Part-time enrollment, at the certificate level, ranges from three to 500. Conversely, of the total number of students enrolled in diploma programs, 97% are reported as full-time. At the associate level, 90% of the total students are enrolled full-time, while 97% of the total baccalaureate students are categorized as full-time. At the graduate level, 64% of the total masters level students are full-time and 96% of the doctoral students are full-time. Clearly the associate and masters level programs illustrate the highest percentage of part-time students. Graduates per annum range from less than one to as many as 185.

Overall, 54% of the programs presented in the wastewater volumes are identified as stable regarding enrollment and graduates. An increase was reported by 27% of the programs, while only 8% are characterized by a slight downward trend. It is noted that 11% of the programs were unable to supply the information.

C. Faculty

Total faculty, as depicted in the two wastewater volumes, include 1,106 persons from the 88 institutions visited. Full-time faculty comprise 73% (802 members); and, part-time faculty compose the remaining 27% (304 members). The majority of the faculty members interviewed, devote time and effort to research activities, consulting and/or advisory committees, in addition to their respective program responsibilities.

Full-time faculty members are usually defined as "cost-centered" (supported through the department). Although these persons are involved in research activities, their major support is not dependent upon the availability of contracts and grants. However, part-time faculty are often supported as a direct result of research monies. In addition, part-time personnel may teach only one course per semester.

No attempt was made to develop a faculty-student ratio. A ratio of this nature was deemed less than meaningful for several reasons, which include: some faculty are engaged primarily in research or in administration; a variety of departments supply faculty for occasional courses; and, some faculty members are responsible for teaching overloads (additional courses).

Many faculty members interviewed are defined as prestigeous representatives of their environmental area. The majority of these persons maintain memberships in a variety of professional organizations. Many of those professionals interviewed are represented on national advisory committees and have achieved renouned reputations as major research contributors to their fields.

D. Curricula

A number of similarities in program structure (including curricula) may be noted upon review of the programs included in the wastewater volumes. At the certificate/associate degree level, general courses in chemistry, math and biology plus fundamental instruction in wastewater treatment plant operations, usually make-up the core in the majority of programs. Many of the certification and diploma programs are upgrading programs for persons already employed in the field. The associate degree programs, for the most part, train personnel to enter the field and require hands-on experience in treatment plants.

Programs at the baccalaureate level are predominately components of civil or environmental engineering departments. For the most part, these programs require a strong background in physical and natural sciences, and tend to emphasize the degree of rigour reflected in the traditional engineering programs.

Graduate level programs generally interface and complement the undergraduate programs. However, more flexibility and often a wider variety of course offerings, allow for the specialization required at this level.

In order for programs to be responsive to changing needs of students and society, flexibility is the amount of time needed to implement a new course and/or to add a new program. Most institutions can add a new course within one semester. Programs which do not require additional funding or manpower can usually be established within one year. Community colleges usually are able to implement these changes more quickly than colleges and/or universities.

E. Research Funding and Sources of Student Financial Support

Research funding and student financial support is derived from a variety of sources, both public and private. The U.S. Environmental Protection Agency provides a substantial number of research grants to most of the major institutions. It was noted that both the number and the amount of these funds, however, is declining. Most program personnel also reflected upon the decline in training monies, especially at the community level.

The majority of the research funding was reportedly channeled toward graduate level research, and often is characterized as a major part-time faculty support mechanism. Student support or assistance is often dependent upon the number of acquired research grants and contracts. Financial aid for graduate students was mainly identified in the form of research assistantships. The undergraduate level financial assistance usually takes the form of the traditional financial aid packages. It was observed that at least one-half of the students attending private institutions (in wastewater programs) were receiving some form of financial assistance.

F. Employment

The following table illustrates the employment profiles, in summary, for the two wastewater volumes, and includes only the students reflected within these volumes.

WASTEWATER EMPLOYMENT PROFILE SUMMARY

	Private Sector				
Degree	Industry	Consulting	Total	Government	Other
Certificate[1]	36%	1%	37%	63%	-
Diploma	59%	21%	80%	18%	2%
Associate	30%	4%	34%	65%	1%
Bachelors	37%	29%	66%	31%	3%
Masters[2]	32%	28%	60%	35%	5%
Env. Eng.	8%	41%	49%	33%	18%
Doctoral[3]	31%	27%	58%	22%	20%

[1] Does not include Stevens Institute of Technology for which figures were unavailable.

[2] Does not include New Jersey Institute of Technology for which figures were unavailable.

[3] Does not include Rensselaer Polytechnic Institute for which figures were unavailable.

The table illustrates the percentage of graduates entering employment in the private sector and the public sector. For the most part, graduates of less than four year institutions predominantly enter public sector employment. As reported, 63% of the graduates from wastewater certification programs enter positions in the public sector, usually as wastewater operators or technicians. Similarly, associate degree programs report 65% of their graduates entering the public sector. While only 18% of students from diploma programs are reported to enter the public sector employment, this figure may be skewed by the relatively small number of programs represented.

Graduates of bachelors, masters and doctoral degree programs tend to enter private sector employment. The major reason reported, is higher salary levels. Active recruitment by private companies on college campuses tends to influence the number of qualified students entering the private sector, historically, state and local governments are unable to meet this economic challenge.

Graduate follow-up is often a useful means of evaluating one's programs. The majority (72%) of institutions visited, report some form of graduate follow-up. For the most part, program personnel were able to describe the most frequently entered occupations by the graduates. Occupations listed below are a result of selection from 28 wastewater related occupations.

Programs represented at the certificate, diploma or associate degree level report graduates entering the following occupations.

- Engineering Aide
- Industrial Waste Inspector
- Water Analyst
- Water/Wastewater Treatment Operator
- Safety and Sanitary Inspector

At the baccalaureate level, employment includes the above and in addition, the following occupations:

- Environmental Engineer-
  Water Pollution Control
- Sanitary Engineer
- Chemist
- Aquatic Biologist

At the graduate level, most students find employment with private consulting firms or governmental agencies as Environmental Engineers. The majority of students enter the following occupations:

- Environmental Engineer
- Water Resources Engineer
- Supervisor-Wastewater
- Water Pollution Control Biologist
- Sanitary Engineer
- Superintendent-Water and Sewer Systems
- Health Physicist

The reader is cautioned to remember that job descriptions vary from one level to the next. Therefore, an occupation may occur at both the associate and graduate level such as "Superintendent-Water and Sewer Systems" but job responsibilities will differ.

Students of doctoral programs often enter university positions which was not listed as one of the occupational choices.

Graduates of less than four year institutions usually find employment with a municipal or private wastewater treatment plant as operators. It is through promotion and continuing education that these people advance to higher level positions. Graduates of these programs have little difficulty finding employment.

Students with bachelors degrees often return to school for a masters degree after a few years of employment. Those employed with advanced degrees are predonimantly products of Environmental Sanitary Engineering programs. The majority of graduates find employment in their field of study and have a great deal of lateral movement.

PROJECT BACKGROUND

Photo reprinted from the University of Wisconsin, Madison Oceanography and Limnology Catalog

PROJECT BACKGROUND

OVERVIEW:

In late 1975, Congress acknowledged the growing national concern for the preservation and conservation of our national resources with a direct inquiry into the availability and readiness of our environmental workforce. That inquiry has taken the form of a three-year, three-phase National Environmental/Energy Workforce Assessment, currently being conducted by National Field Research Center under the direction of the U.S. Environmental Protection Agency. In keeping with the objective of the assessment, this three-phase national effort directs itself at environmental/energy workforce needs, national educational preparedness, and the functional relationship between the two.

PHASE I:

Phase I of the National Environmental/Energy Workforce Assessment focused upon the development of "workforce demand projections" through 1982 for all public environmental agencies. This on-site assessment, which was carried out in all 50 states, Puerto Rico and the Virgin Islands, culminated in a numerical profile of the growth patterns and workforce needs at the national and state levels. Stratification of the overall definition of "environmental occupation" into seven distinct vocational areas enhanced even further the applicability of the results. In addition to this public sector workforce assessment, Phase I included an overview analysis of private sector needs (through an adjunct mail survey of selected businesses and industries) and a brief review of selected environmental educational programs.

Phase I was completed in May, 1977. The 70-volume final report included:

* National Abstract	(1)
* National Legislation	(1)
* Regional Assessments	(10)
* State Assessments (including D.C., VI and PR)	(53)
* Business and Industry Assessment	(1)
* National Summary	(4)

PHASE II:

Phase II of the National Environmental/Energy Workforce Assessment was structured around an intensive on-site inventory of representative environmental educational offerings on a national scale. The primary objective of this project has been to collect and aggregate data on training and educational programs in both the post-secondary education field and in the private sector and to do so by environmental area. Specifically, the study was designed to provide an overview of environmentally related post-secondary education programs, their program structure, representative course offerings, employment history of the graduates, and the faculty structure. Additionally, information was to be collected on program requirements and program projections.

Initially, opportunities to nominate programs for inclusion in this on-site review process was given to the Environmental Protection Agency and its program officers and regional personnel both through the

Project Officer and via direct mail requests; all state departments of education; state environmental agencies and selected media-specific associations. These nominations were supplemented by a direct review of institutional catalogs, information obtained during the first year's on-site activities, and a review of other published sources of information regarding degree programs in environmental areas. These sources are included in Appendix III - Selected Bibliography.

Following their initial development, the lists of nominees were forwarded to the program officers for suggestions regarding additions or deletions. Next, letters were written to those nominated institutions seeking their support and cooperation in the on-site review process. Several programs, some of which were highly recommended, declined the opportunity to participate giving reasons varying from lack of time to the fact that the program being inquired about no longer existed, to outright refusal to cooperate with any government study. These institutions were deleted from the final on-site process. The remainder were included in the study and are shown in Table 1 of each volume. Selection of the sample for the private sector is discussed in depth in that particular volume.

In preparation for the on-site interviews, appropriate persons were contacted in the institution involved and were given a background description of the study, a suggested timetable for the interview process and were told what kind of information was being sought. This was all done in an effort to keep the time involvement of the individual contact persons at a minimum. During the actual on-site interview, generally lasting around one hour, the information was collected, questions asked and answered, and further informational contacts identified. Following

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this process, each on-site interview was written up in the form of a Training Program Summary, which where time allowed, was returned to the contact person for critiquing prior to inclusion in the report.

Throughout this process, individuals and institutions were given assurance that this study was not an attempt to evaluate program offerings and every attempt has been made on the part of the writers to live up to this assurance. Inclusion in this report provides no assurances of quality, nor should a program's exclusion be consideration of the lack thereof. In many instances certain programs within an institution were not included while others were, primarily due to the determination of the sample - previously discussed. This too should not be viewed in any qualitative manner.

REPORT ORGANIZATION:

The final report, of which this volume is a part, consists of volumes depicting a training profile in each medium under consideration, namely,

Air
Energy
Noise
Pesticides
Potable Water
Radiation
Solid Waste
Wastewater
Composite
Business and Industry and Trade Associations

At the outset it should be pointed out that there are very few degree programs conveying degrees in a particular medium; rather, degrees are offered in various specialties which lend themselves to obtaining employment in one or more of these fields. Nonetheless, to obtain maximum utility for the funding agency, programs were reported in this fashion. The Composite section was necessitated by the number of programs offering course work in multiple fields and differing specializations resulting from course selection. For convenience in handling of the data Potable Water, Wastewater and Composite have been reported in multiple volumes because of the numbers involved. Although separated into volumes either by degree level of the programs involved, as in the case of Potable Water and Wastewater, or by content as in the case of Composite, persons interested in any of these fields would be well advised to review each of the volumes to assure more complete coverage.

Along with the standard introductory pages common to volumes of this nature, each volume contains sections on Project Background, Introduction (consisting of sections devoted to a description of the programs surveyed and covered in the volume), Project Commentary, and the Training Summaries along with the Appendices.

REVIEW PROCESS:

In addition to individual training summary reviews conducted by the persons initially interviewed, each volume has been reviewed internally, by persons in the Environmental Protection Agency and by a select group of review committee members. In the final instance, individuals met during the on-site process were nominated by interviewers for inclusion on the review committee, primarily as a result of their obvious expertise in the field and their evidenced interest in the project.

These persons were then contacted by mail or by telephone in an effort to determine their willingness to serve. The rather stringent timelines necessary to keep the project on course and to deliver the finished product as specified were also detailed. In excess of one hundred persons returned their volumes (out of a mailing of 120) and all but five of these provided usable responses. In these five instances either last minute job demands prevented them from carrying out the review in the short timelines, or (in two instances) individuals indicated that they wanted nothing to do with the process. This particular method of review provided a wealth of valuable information, suggestions for revision of specific elements, and general comments helpful in revising the final documents. In all cases an effort was made to seriously consider and incorporate reviewer suggestions. The persons on the various review committees are individually acknowledged in the front of the volume they reviewed.

Photo reprinted from the University of Missouri, Columbia Bulletin 1977.

INTRODUCTION

Photo reprinted from the Northland College Catalog 1975-76

INTRODUCTION

The Federal Water Pollution Control Act Amendments of 1972 (PL 92-500) are considered to represent some of the most complex and comprehensive environmental measures enacted by Congress. This legislation includes a synthesis of 24 years of experience, most of which was viewed as disappointing, regarding pollution control and abatement. The primary goals of this legislation emphasize the restoration and maintainence of the chemical, physical and biological integrity of our waters. In addition to controlling point source pollution, the Act authorizes major research and demonstration efforts aimed at the elimination of pollutants generated by non-point sources.

In order to meet anticipated environmental manpower needs, the Manpower Planning and Training Branch of the U. S. Environmental Protection Agency developed the Operator Training Program at the state and local level for the training and certification of operators. In addition, the Academic Program was developed to provide financial assistance through state agency fellowships as well as professional training institutions for the development of professional agency personnel involved in water quality programs. The Academic Training Program was charged to develop and to administer training and demonstration grants for the development of new curricula and training resources. Between the yeare 1972 and 1974, many postsecondary institutions added new programs to existing civil and sanitary engineering departments, or created new interdisciplinary programs to address water quality problems and solutions. Community colleges and technical schools accelerated training of students for employment in wastewater treatment plants.

This report describes 105 programs from public and private postsecondary institutions, and provides interested readers with a representation of the types of programs currently being conducted including pertinent statistics regarding enrollment and employment. Research funding, student support, recruitment techniques, program flexibility, graduate follow-up and student origin are also discussed.

The total wastewater programs number 105 of which 47 are detailed in Wastewater Volume I, and 58 in Wastewater Volume II. The report is presented in two volumes due to the extensive number of wastewater programs which were identified for includion by the project staff.

Many of the institutions and the programs offer a variety of degrees or certifications. The Wastewater Volume II describes 58 programs in of multiple degree offerings. A representation of the single degree offerings may be found in Wastewater Volume I.

Program summaries have been arranged in accordance with academic level. The following types of programs are presented: certificate, diploma, and associate degree; associate and bachelors degrees; bachelors and masters degrees; bachelors, masters and doctoral degrees; and, masters, environmental engineer, and doctoral degrees.

Extensive catalogue review was conducted by the project staff. A catalogue was requested from every accredited junior college, community college, four year college and university within the United States. The catalogue requests totaled 3.055; catalogues received and reviewed numbered 1,872; and, 105 programs were selected for inclusion of which 58 are presented in this volume. For a complete listing of all of the institutions by environmental category, the reader is referred to Appendix IV.

TABLE I

PARTICIPATING INSTITUTIONS

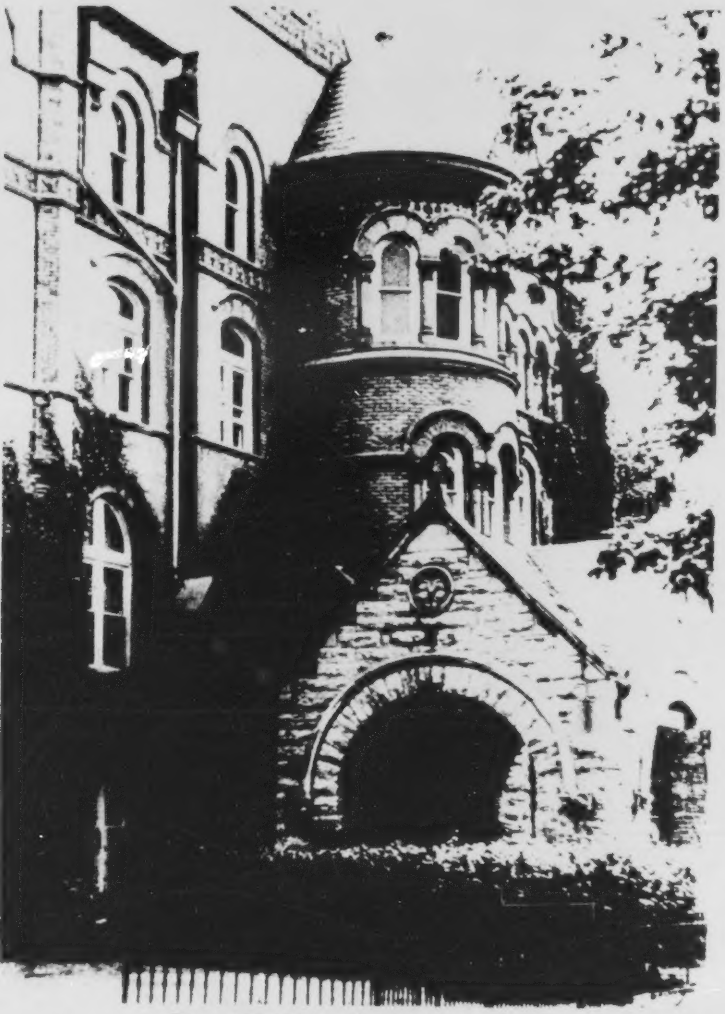

Photo reprinted from the Macalester College 1976-78 Catalog

Table 1 is a comprehensive listing of all institutions which participated in the post-secondary educational profile of the *National Environmental/Energy Workforce Assessment.* Listed by state, institution, and degree are programs surveyed in the areas of air, energy, noise, pesticides, potable water, radiation, solid waste and wastewater.

An explanation of the degree abbreviations utilized within the report may be found in Appendix I, entitled "Degree Abbreviations". For a complete listing of the institutions visited in a media specific area (i.e., air, energy, etc.), attention is drawn to Appendix IV, entitled "Participating Institutions by Environmental Category".

The Table in part III of the Project Findings, entitled "A Summary Profile of Representative Educational Programs" follows the narrative and is a presentation of specific institutions visited for the particular volume.

TABLE I

PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)*
AL	University of Alabama University	Environmental Engineering	M.S. (3)
AK	University of Alaska Fairbanks	Environmental Quality Engineering Science	M.S.
AR	University of Arkansas Fayetteville	Agricultural Engineering	B.S. M.S. Ph.D.
		Civil Engineering	M.S.C.E.
		Environmental Engineering	M.S.En.E.
		Environmental Science	B.S.
CA	California Institute of Technology Pasadena	Environmental Engineering Science	M.S. Ph.D.
	California Polytechnic State University San Luis Obispo	Environmental Engineering	B.S.
	California State University-Sacramento Sacramento	Civil and Environmental Engineering	B.S. M.S.
	Stanford University Stanford	Environmental and Water Studies	M.S. Ph.D.
	University of California-Berkeley Berkeley	Nuclear Engineering	B.S. M.S. M.E. Ph.D. D.E.
		Pest Management	B.S.
		Sanitary Engineering	M.S. M.E. Ph.D.
	University of California-Davis Davis	Environmental Toxicology	B.S.
		Plant Protection and Pest Management	M.S.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of California-Davis (Cont'd)	Entomology	B.S. M.S. Ph.D.
	University of California-Riverside Riverside	Pest Management	M.S.
	University of California-Santa Barbara Santa Barbara	Environmental Studies	B.A.
CO	Colorado State University Fort Collins	Environmental Engineering (Civil)	M.S. Ph.D.
	Community College of Denver-Red Rocks Golden	Water-Wastewater Technology	A.A.
CT	Hartford State Technical College Hartford	Nuclear Engineering Technology	A.S.
	Yale University New Haven	Environmental Health	M.P.H.
DE	Delaware Technical and Community College Newark	Environmental Engineering Technology	A.A.S.
	University of Delaware Newark	Entomology and Applied Ecology	B.S.
		Environmental Engineering	M.A.S. M.E. Ph.D.(App. Science) Ph.D.(ChE)
DC	Catholic University Washington	Civil Engineering	B.S.
	Howard University	Environmental Engineering	M.E.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
FL	Broward Community College Fort Lauderdale	Pest Control Technology	A.S.
	Central Florida Community College Ocala	Radiological Health Technology	A.S.
	Florida International University Miami	Environmental Studies	B.A. B.S.
		Environmental Engineering Technology	B.S.
	Heed University Hollywood	Ocean and Environmental Affairs	M.A. Ph.D.
	Miami-Dade Community College Miami	Environmental Engineering Technology	A.S.
		Marine Science Technology	A.S.
	University of Florida Gainesville	Air Pollution	M.E. M.S. Engineer Ph.D.
		Environmental Biology	M.E. M.S. Engineer Ph.D.
		Environmental Resources Management Activities	M.E. M.S. Engineer Ph.D.
		Systems Ecology	M.E. M.S. Engineer Ph.D.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of Florida (Cont'd)	Water Supply and Water Pollution Control	M.E. M.S. Engineer Ph.D.
		Nuclear Engineering	B.S.(N.E.) B.S.E.(N.E.) M.E. M.S. Engineer Ph.D.
		Radiological Sciences	M.E. M.S.
	University of Miami Miami	Marine and Atmospheric Science	M.S. Ph.D.
GA	Abraham Baldwin Agricultural College Tifton	Plant Protection	A.Ag.
	Atlanta University Center/ Georgia Institute of Technology Atlanta	Water Pollution Control Design Engineering	B.S. B.E.
	Georgia Institute of Technology Atlanta	Acoustical Engineering	Advanced Cert.
		Energy Engineering	Advanced Cert.
		Environmental Studies	Advanced Cert.
	Southern Technical Institute Marietta	Nuclear Safety	A.S.
	University of Georgia Athens	Entomology	B.S. A.B. M.S. M.P.P.P.M. Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of Georgia (Cont'd)	Environmental Health Science	B.S.E.H.
HI	University of Hawaii Honolulu	Environmental and Sanitary Engineering	M.S.
IL	Illinois Institute of Technology Chicago	Environmental Engineering	B.S.E.S. M.S. Ph.D.
	Prairie State Community College Chicago Heights	Air, Water, Wastewater	A.A.S.
	Sangamon State University Springfield	Environments and People	B.A. M.A.
	Southern Illinois University-Edwardsville Edwardsville	Wastewater Treatment Operator Training	Cert.
IN	Indiana University Bloomington	Environmental Programs	Cert. A.S. B.A. B.S. M.P.A. M.S.E.S. Ph.D. (minor)
	Purdue University West Lafayette	Environmental Sciences Option	B.S.
		Nuclear Engineering	B.S.N.E. M.S. Ph.D.
IA	Iowa State University Ames	Environmental Studies	B.A. B.S.
		Sanitary Engineering and Water Resources	M.S. Ph.D.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Kirkwood Community College Cedar Rapids	Environmental Health Assistant	Diploma
		Environmental Health Technician	A.A.
		Water and Wastewater	Diploma
	University of Iowa Iowa City	Environmental Engineering	M.S. Ph.D.
		Environmental Toxicology	M.S. Ph.D.
KS	Kansas State University Manhattan	Chemical Engineering	B.S. M.S. Ph.D.
		Mechanical Engineering	B.S. M.S. Ph.D.
		Nuclear Engineering	B.S. M.S. Ph.D.
		Sanitary Engineering	M.S.C.E.
	University of Kansas Lawrence	Environmental Health Engineering	M.S. Ph.D.
		Environmental Health Science	M.S. Ph.D.
		Environmental Studies	B.A.
		Radiation Biophysics	B.A. B.S. M.S. Ph.D.
		Water Resources Engineering and Science	M.S. Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
KY	Morehead State University Morehead	Environmental Studies	B.S. A.B.
		Mining Technology	A.A.S.
	Pikeville College Pikeville	Mining Technology	A.M.T.
	University of Kentucky Lexington	Energy (Coal) Engineering	M.S. Ph.D.
		Environmental Engineering	M.S. Ph.D.
	University of Louisville Louisville	Environmental Engineering	B.S. M.Eng.
	Western Kentucky University Bowling Green	Environmental Science	B.S.
		Environmental Engineering	B.S.
LA	Delgado College New Orleans	Urban Pest Management	A.S.
		Water/Wastewater Technology	A.S.
		Environmental Health Technology	A.S.
	McNeese State University Lake Charles	Environmental Science	B.S. M.S.
ME	Eastern Maine Vocational Technical Institute Bangor	Environmental Control Technology	A.A.S.
	New England Regional Wastewater Institute (S. Maine Vocational Technical Institute) S. Portland	Wastewater Treatment Technology	Cert.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of Maine-Orono Orono	Sanitary Engineering	M.S.C.E. Ph.D.
MD	Charles County Community College La Plata	Pollution Abatement Technology	A.A.
	Johns Hopkins University Baltimore	Environmental Engineering	M.A. M.S.E. M.S. Ph.D
	University of Maryland College Park	Environmental Engineering	M.S.
		Nuclear Engineering	M.S.
		Pest Management	M.S.
MA	Harvard University Cambridge	Environmental Health Sciences	S.M. Sc.D.
		Environmental Sciences and Engineering	S.M. M.E. Ph.D.
		Toxicology	S.M. Sc.D.
	Massachusetts Institute of Technology Cambridge	Acoustics	S.M. Sc.D./ Ph.D.
		Environmental Engineering	Env.E.
		Mineral Resources Engineering and Management	S.M. Engr. Sc.D./ Ph.D.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Massachusetts Institute of Technology (Cont'd)	Nuclear Engineering	S.B. S.M. N.E. Sc.D./ Ph.D.
		Water Resources and Environmental Engineering	S.B. S.M. Sc.D./ Ph.D.
		Wastewater Treatment Plant Operations	Cert.
	Northeastern University Boston	Environmental Engineering and Science	M.S.
	Springfield Technical Community College Springfield	Environmental Technician	A.S.
	Tufts University Medford	Environmental Health Engineering	B.S.C.E. M.S.
	University of Lowell Lowell	Radiological Health Physics/Radiological Sciences and Protection	B.S. M.S.
		Wastewater Treatment Plant Operations	Cert.
MI	Ferris State College Big Rapids	Environmental Health Technician	A.A.S.
		Environmental Health	B.S.
	Michigan State University East Lansing	Environmental Conservation Education	M.S. Ph.D.
		Environmental Engineering	B.S.C.E. M.S. (emphasis) Ph.D. (emphasis)

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Michigan State University (Cont'd)	Natural Resources and Environmental Education	B.S.
		Systems Science (Ecological Systems)	B.S. M.S. Ph.D.
	Michigan Technological University Houghton	Environmental Engineering	B.S.C.E. B.S.E. M.S.C.E.
	University of Michigan Ann Arbor	Environmental Education	M.S.
		Environmental Sciences Engineering	B.S.
		Industrial Hygiene and Air Pollution	M.P.H. M.S. Dr.P.H. Ph.D.
		Radiological Health	M.P.H. M.S. Dr.P.H. Ph.D.
		Water Resources: Engineering	M.S.E. Ph.D.
		Management Science	M.S. Ph.D.
		Water Quality	M.P.H. M.S. Dr.P.H. Ph.D.
MN	Bemedji State College Bemedji	Environmental Studies	B.S. M.A.
	Macalester College St. Paul	Environmental Studies	B.A. B.S.
	University of Minnesota Minneapolis	Environmental Health	M.P.H. M.S. Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
MS	Mississippi State University Mississippi State	Specialized Training in Pest Management	M.Ag.
MO	Missouri Southern State College Joplin	Environmental Health Technology	A.S. B.S.
		Radiologic Technology	A.S.
	St. Louis Community College at Forest Park St. Louis	Radiologic Technology	A.S.
	University of Missouri-Columbia Columbia	Sanitary Engineering	B.S. M.S. Ph.D.
	University of Missouri-Rolla Rolla	Environmental and Sanitary Engineering	M.S. Ph.D.
	Water and Wastewater Technical School Neosho	Water and Wastewater Training	Cert.
	Washington University St. Louis	Air (emphasis)	M.S. D.Sc.
MT	Montana State University Bozeman	Environmental Engineering	M.S.
		Environmental Health Technology	M.S.
	Northern Montana College Havre	Environmental Health Technology	A.A. Cert.
NE	Central Technical Community College Hastings	Agriculture Technology	Cert. 1-Year Diploma 2-Year Diploma A.A.S. A.S.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of Nebraska Lincoln	Sanitary Engineering	B.S. M.S. Ph.D.
		Water Resources Engineering	M.S.
		Planning and Management	M.S.
NH	University of New Hampshire Durham	Entomology	B.S. B.A.
NJ	Middlesex County College Edison	Environmental Health Science Technology	A.A.S.
	New Jersey Institute of Technology Newark	Interdisciplinary Studies in Environmental Engineering	M.S.
	Princeton University Princeton	Energy Conversion and Resources	Topical Programs
	Rutgers-SUNJ New Brunswick	Biology (option in entomology)	B.S. B.A.
		Entomology and Economic Zoology	M.S. M.P. Ph.D.
		Environmental and Business Economics	B.S.
		Environmental Science	M.S. Ph.D.
		Environmental Studies	B.S.
		Environmental and Water Resources Engineering	M.S. Ph.D.
		International Environmental Studies	B.A. B.S.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Rutgers-SUNJ (Cont'd)	Radiation Sciences	M.S. Ph.D.
	Stevens Institute of Technology Hoboken	Air Pollution Control Engineering	Cert.
		Water and Wastewater Engineering	Cert.
NM	New Mexico State University Las Cruces	Pest Management	B.S.
	University of New Mexico Albuquerque	Nuclear Engineering	M.S. Ph.D.
NY	Clarkson College Potsdam	Civil and Environmental Engineering	B.S. M.S.
	Columbia University New York City	Nuclear Engineering	B.S. M.S. Nuc.Engr. Eng.Sc.D.
	Cornell University Ithaca	College Program in Energy Conversion	B.S.
		Environmental Engineering	B.S. M.S. M.Eng. Ph.D.
		Waste Management Engineering	M.S. M.Eng. M.P.S. Ph.D.
		Nuclear Engineering	M.Eng. M.S. Ph.D.
	Hofstra University Hempstead	Solid Waste Management	Cert.
	Hudson Valley Community College Troy	Public Health Technology (Environmental option)	A.A.S.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Hunter College New York City	Environmental Health Science	B.S. M.S.
	Manhattan College New York City	Environmental Engineering and Science	M.S. M.E.
	Polytechnic Institute of New York New York City	Energy Engineering and Policy	Cert. M.S.
		Environmental Engineering and Planning	M.S.C.E. M.E.H.S. Engr. Ph.D.
	Rensselaer Polytechnic Institute Troy	Environmental Engineering	B.S. M.E. M.S. D.E. Ph.D.
		Nuclear Engineering	B.S. M.S. M.E. Ph.D.
	Rochester Institute of Technology Rochester	Civil Engineering Technology (Environmental option)	B.T.
	State University of New York-Buffalo Buffalo	Water Resources and Environmental Engineering	B.S. M.S. Ph.D.
	State University of New York Farmingdale	Pest Control Technology	A.A.S.
	Syracuse University Syracuse	Chemical Engineering	B.S. M.S. Ph.D.
		Environmental Engineering	B.S.
		Sanitary Engineering, Sanitary Science, Civil Engineering	M.S.(S.E.) M.S.(S.S.) Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	The Cooper Union New York City	Integrated Master's Program with concentration in Environmental Engineering	M.E.
	Ulster County Community College Stone Ridge	Water Quality Management Training	A.A.S.
	University of Rochester Rochester	Toxicology Training Program	M.S. Ph.D.
NC	Duke University Durham	Environmental Management	M.E.M.
		Civil Engineering/ Urban and Environmental Engineering	M.S. Ph.D.
	North Carolina State University Raleigh	Agricultural Pest Control	A.A.S.
		Pest Management	B.S. M.S. (minor)
		Air Conservation	M.S. (minor) M.E. (minor) Ph.D.(minor)
		Environmental Engineering	M.S. M.C.E. Ph.D.
		Acoustic, Noise Vibration	M.S. M.M.E. Ph.D.
	University of North Carolina Chapel Hill	Air and Industrial Hygiene	M.S. M.S.P.H.
		Environmental Chemistry and Biology	M.S. M.S.P.H. Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of North Carolina (Cont'd)	Environmental Management Protection	M.S. M.S.P.H. Ph.D.
		Radiological Hygiene	M.S. M.S.P.H. Ph.D.
		Water Resources Engineering	M.S. M.S.P.H. M.S.E.E. Ph.D.
	Wilson County Technical Institute Wilson	Sanitary Landfill Operating Manager	Cert. Diploma A.A.S.
		Sanitary Landfill Technology	A.A.S.
ND	North Dakota State School of Science Wahpeton	Environmental Science Technology	A.A.
OH	Antioch College Yellow Springs	Environmental Studies	B.S.
	Hocking Technical College Nelsonville	Environmental Health Technology	A.A.S.
	Miami University Oxford	Environmental Science	M.En.
	Muskingum Area Technical College Zanesville	Environmental Quality Control Technology	A.A.S.
		Natural Resources Conservation Technology	A.A.S.
		Petroleum Engineering Technology	1-Year Cert. A.A.S.
	Ohio State University Columbus	Agricultural Engineering	B.S. M.S. Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Ohio State University (Cont'd)	Chemical Engineering (air)	B.S. M.S. Ph.D.
		Civil Engineering	B.S. M.S. Ph.D.
		Environmental Biology	M.S. Ph.D.
		Environmental Education	B.S.(Ed.) B.S.(N.R.) M.S. Ph.D.
		Toxicology (Pharmacology)	M.S. Ph.D.
	Ohio University Athens	Environmental Studies	M.S.
	Raymond Walters General and Technical College (University of Cincinnati) Cincinnati	Environmental Control/ Protection Technology	A.S.
	University of Cincinnati Cincinnati	Air Pollution and Industrial Hygiene	M.S. Ph.D.
		Civil and Environmental Engineering	M.S. Ph.D.
		Environmental Health	M.S. Ph.D.
		Mechanical and Industrial Engineering (noise)	B.S. M.S. Ph.D.
		Occupational Medicine	M.S. Ph.D.
		Toxicology	M.S. Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of Cincinnati (Cont'd)	Acoustics and Noise Control	B.S. M.S. Ph.D.
	University of Toledo Toledo	Chemical Engineering, Civil Engineering	B.S. M.S.
		Engineering Science	M.S.
OK	East Central Oklahoma State University Ada	Environmental Science	B.S.
	OSU Oklahoma City Technical Institute Oklahoma City	Civil Technology	A.S.
	Oklahoma State University Stillwater	Engineering Technology	A.D. B.S.
		Radiation and Nuclear Engineering Technology	A.D. B.S.
	Oscar Rose Junior College Midwest City	Wastewater Technology	A.A.S.
		Environmental Science	A.A.S.
	University of Oklahoma Norman	Environmental Science	B.S. M.S. Ph.D.
OR	Linn-Benton Community College Albany	Wastewater Technology	A.S.
		Water/Wastewater Technology	A.S.
		Water/Wastewater Plant Operator	Cert.
	Oregon Institute of Technology Klamath Falls	Environmental Technology	A.A.S. B.T.
	Oregon State University Corvallis	Nuclear Engineering Technology	B.S.
		Nuclear Engineering	B.S. M.S.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Oregon State University (Cont'd)	Pest Management and Plant Pathology	B.S. M.S.
	Portland State University Portland	Engineering and Applied Science	B.S. M.S.
PA	Carnegie-Mellon University Carnegie Institute of Technology Pittsburgh	Environmental Engineering	B.S. M.S. Ph.D.
	Drexel University Philadelphia	Environmental Engineering and Science	M.S.E.E. M.S.E.S. Ph.D.
	Pennsylvania State University University Park	Acoustics	M.E. M.S. Ph.D.
		Air Pollution Control Technology	A.A.P.C.T.
		Entomology	B.S. M.Agr. M.S. Ph.D.
		Environmental Engineering	B.S. M.S. M.E.E.E. Ph.D.
		Environmental Pollution Control	M.S. M.E.P.C. M.E.
		Environmental Resource Management	B.S.
		Minerals Processing	M.S. Ph.D.
		Mining Technology	A.A.S.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Pennsylvania State University (Cont'd)	Mining Engineering	B.S. M.S. M.E. Ph.D.
		Nuclear Engineering Technology	A.N.E.T.
		Nuclear Engineering	B.S. M.S. M.E. Ph.D.
		Petroleum and Natural Gas Engineering	B.S. M.S. Ph.D.
		Water Resources Engineering Technology	B.T.
	Slippery Rock State College Slippery Rock	Environmental Studies	B.S.
	Temple University Philadelphia	Environmental Technology	A.T.
		Environmental Engineering Technology	B.S.
	University of Pennsylvania Philadelphia	Energy Engineering	M.S.E.
		Energy Management and Policy	M.S.E.M.P. Ph.D.
	University of Pittsburgh Pittsburgh	Environmental and Sanitary Engineering	B.S. M.S. Ph.D.
		Environmental Systems Engineering	degrees granted through Engr. Dept.
	School of Public Health (University of Pittsburgh) Pittsburgh	Acoustic Environmental Control	M.S.(Hyg.) D.S.(Hyg.)
		Air Resources	M.S.(Hyg.)

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	School of Public Health (University of Pittsburgh) (Cont'd)	Environmental Health Engineering	M.P.H. D.S.(Hyg.)
		Environmental Health Planning	D.S.(Hyg.)
		Health Aspects of Water Quality	M.S.(Hyg.)
		Industrial Hygiene	M.S.(Hyg.)
		Toxicology	D.S.(Hyg.) Ph.D.
		Radiation Health	M.S.(Hyg.) D.S.(Hyg.) Ph.D. D.P.H.
RI	University of Rhode Island Kingston	Environmental Engineering	B.S. M.S. Ph.D.
SC	Clemson University Clemson	Air Pollution	M.S. M.Engr.
		Natural Systems	M.S. M.Engr.
		Planning and Management	M.S. M.Engr.
		Water Treatment Systems	M.S. M.Engr.
		Environmental Systems Engineering	Ph.D.
	Greenville Technical College Greenville	Wastewater Technology	A.A.S.
	Sumter Area Technical College Sumter	Environmental Engineering Technology	A.E.T.
TN	Chattanooga State Technical Community College Chattanooga	Environmental Science Technology	A.S.
		Nuclear Technology	A.S.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	East Tennessee State University Johnson City	Environmental Health	B.S.E.H. M.S.E.H.
	Memphis State University Memphis	Audiology	M.A. Ph.D.
	Middle Tennessee State University Murfreesboro	Environmental Science and Technology	B.S.
	State Technical Institute at Memphis Memphis	Environmental Engineering Technology	A.E.
	University of Tennessee Knoxville	Environmental Engineering	M.S.E.E. M.E. Ph.D.
		Environmental Engineering (Air Quality and Pollution Control)	M.S.E.E. M.E. Ph.D.
		Environmental Engineering (Water Pollution Control/ Water Resources)	M.S.E.E. M.E. Ph.D.
		Industrial Audiology	M.A.
		Nuclear Engineering	B.S. M.E. M.S. Ph.D.
		Water Resources Development	M.S.
	Vanderbilt University Nashville	Environmental and Water Resources Engineering (EWRE)	B.E.
		Environmental Science	B.S.
		EWRE (Environmental Science)	M.S. M.Eng. Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Vanderbilt University (Cont'd)	EWRE (Air Resources)	M.S. M.Eng. Ph.D.
		EWRE (Solid Waste)	M.S. M.Eng. Ph.D.
		EWRE (Water and Wastewater Treatment/Water Resources)	M.S. M.Eng. Ph.D.
TX	Baylor University Waco	Institute of Environmental Studies	B.A. B.S.
	Lamar University Beaumont	Environmental Science	B.S.
		Energy Resource Management	B.S.
	Rice University Houston	Environmental Science and Engineering	M.S.
	Sam Houston State University Huntsville	Environmental Science	B.S.
	Texas A & M University College Station	Environmental Engineering	M.S. Ph.D.
		Entomology	M.S.
		Entomology/Pest Management Option	M. Ag.
	Texas State Technical Institution Waco	Nuclear Technology	A.A.S.
		Water/Wastewater Technology	A.A.S.
		Water Utility Operator	Certificate
	University of Texas Austin	Environmental Health Engineering	M.S. Ph.D.
		Water Resources Engineering	M.S. Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
UT	Brigham Young University Provo	Chemical Engineering	B.S. M.S.
		Water Resources and Environmental Engineering	B.S. M.S.
	University of Utah Salt Lake City	Civil Engineering	B.S. M.E. M.S. Ph.D.
	Utah State University Logan	Civil and Environmental Engineering	B.S. M.S. Ph.D.
		Pest Management	B.S. M.S.
		Environmental Studies	B.S.
VA	George Washington University NASA-Langley Institute Hampton	Acoustics	M.S. Sc.D.
		Environmental Modeling	M.S.
	J.Sargeant Reynolds Community College Richmond	Environmental Technology Environmental Operations	Cert. A.A.S.
		Ground Water Resources	Cert.
	Virginia Polytechnic Institute and State University Blacksburg	Civil Engineering Technology	B.S.
		Sanitary Engineering/ Environmental Sciences and Engineering/Civil Engineering	M.S. Ph.D.
	Wytheville Community College Wytheville	Environmental Technology	Cert.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
WA	The Evergreen State College Olympia	Coordinated Studies	B.A.
	University of Washington Seattle	Environmental Studies	B.A. B.S.
		Air Resources	M.S. Ph.D.
	Washington State University Pullman	Environmental Science	B.S. M.S.
		Chemical Engineering	M.S.
		Air Pollution Control Engineering	M.S.
		Air Pollution Science	M.S.
		Air Pollution Option	M.S.
		Air Pollution Program	M.S.
	Western Washington University Bellingham	Environmental Studies	B.S.
WV	Bluefield State College Bluefield	Mining Engineering Technology	A.S. B.S.
	West Virginia Institute of Technology Montgomery	Mining Engineering Technology	A.S.E.M.T. B.E.M.T.
	West Virginia University Morgantown	Engineering of Mines	B.S.
		Environmental Engineering	M.S.C.E. M.S.E.
		Mineral Processing Engineering	B.S. M.S.
		Mineral Resource Economics	M.S.
		Petroleum Engineering	B.S. M.S.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
WI	Marquette University Milwaukee	Environmental Engineering	B.A. B.S.
	Northland College Ashland	Environmental Studies	B.A.
	University of Wisconsin-Green Bay Green Bay	Environmental Emphasis	B.A. B.S. M.E.A.S.
	University of Wisconsin-Madison Madison	Civil and Environmental Engineering	B.S.
		Environmental Communications	M.A. M.S.
		Water Resources Management, Environmental Monitoring, Land Resources	M.S. Ph.D.
	University of Wisconsin-Milwaukee	Atmospheric and Marine Environmental Program	M.S. M.E.
WY	Casper College Casper	Water Quality Technology	A.S.
	University of Wyoming Laramie	Civil Engineering	M.S. Ph.D.

Other Programs

The following programs were included in the on-site visit process and offer training through various institutes, centers, state agencies, or college consortiums. Program descriptions can be found in the volume specified.

State	Institution	Program	Volume
FL	Florida Department of Environmental Regulation	Environmental Noise Control Training	Noise
	Miami-Dade Community College	NPDES Effluent Monitoring Training	Wastewater I
		Wastewater Treatment Plant Operations	Wastewater I
		Water Treatment Plant Operations	Potable Water I
	University of Miami School of Medicine	Pesticide Protection	Pesticides
KS	Kansas State University	Institute for Environmental Research	Composite II III Business and Industry
MI	Michigan State University	Institute of Water Research	Potable Water I
		Pesticide Research Center	Pesticides
NE	University of Mid-America	Pests, Pesticides and Pesticide Safety	Pesticides

State	Institution	Program	Volume
NJ	Princeton University	Environmental Science and Policy	Composite I
NC	U.S. Environmental Protection Agency	Air Pollution Training Institute	Air
OH	Ohio State University	Center for Lake Erie Area Research	Potable Water I
		Cooperative Extension Service Activities	Composite II and III
		Water Resources Center	Potable Water I
PA	Air Pollution Control Association	Refresher, Continuing Education Courses	Air
	University of Pittsburgh	Environmental Systems Engineering	Composite I
TN	Memphis State University	Nuclear Reactor Fundamentals	Energy
		Radiation Technician Training Course	Radiation
	Oak Ridge Associated Universities	Radiation Emergency Assistance Center/ Training Site	Radiation
		Special Training	Energy Radiation
	University of Tennessee Center For Health Sciences	Training Courses in Audiometric Orientation	Noise

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University Bulletin 1977-78

PROJECT
FINDINGS

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University Catalog 1975-76

I A SUMMARY PROFILE OF REPRESENTATIVE WASTEWATER EDUCATIONAL PROGRAMS

A. States, Institutions, Programs and Degrees

Wastewater Volume II presents 58 programs from 24 states. The programs were selected from 45 institutions across the United States, and vary in size and in description from operator training at the local level to advanced degree programs within the universities. The report, in total, contains detailed information, gathered from various sources including on-site interviews for 105 programs, 58 of which are herewithin presented.

Selection of the programs was based on a variety of factors including: information and recommendations obtained during the workforce assessment phase of the project development; a review of all of the available institution's program catalogues; and, a review of other published sources of information regarding degree programs in the environmental area of wastewater pollution control and abatement.

Many of the institutions which were selected by the project staff for on-site visitations conduct programs in several environmental areas, for example, air, solid waste and wastewater. The majority of the programs contained in Wastewater Volume II are also applicable to the area of potable water. These programs, therefore, are identified with an asterisk and may be found within the volumes entitled Potable Water Volume I and Potable Water Volume II.

Reference should be made to Table 8 which appears in Section III of this volume, and is entitled "A Summary Profile of Representative Wastewater Educational Programs". For a complete presentation of all 105 wastewater programs, the reader should refer to Wastewater Volume I in addition to this volume.

The programs presented in Wastewater Volume II are multiple degree programs, and are presented in the section "Wastewater Training Summaries". As depicted in Table 8, 14% of the programs offer certificate, diploma and associate and bachelors degrees; 40% offer bachelors, masters and doctoral degrees; and, 46% of the programs include masters and doctoral degree offerings.

B. Enrollment Statistics and Graduates

The majority of the programs presented in Wastewater Volume II enroll at least 18 full-time students. Programs at the certificate, diploma, associate and bachelors level usually enroll more full-time students, while the doctoral programs may have only a single full-time student. Only 33% of the total programs have part-time students currently enrolled, 12% were unable to supply the information.

Graduates range from zero per year to as many as 120 annually. Overall, 46% of the programs are described as stable relative to changes in the enrollment and the number of graduates per annum. Of the total, 31% are described as illustrating increased numbers of graduates, while 9% are described as decreased. The remaining 14% of the programs are categorized as information not available. Proportionately, the largest percentage of programs illustrating an increase in numbers of graduates annually is 15 at the masters level (44%), and 27% at the bachelors level, while 20% of the doctoral level programs indicate an upward trend.

The table on the following page (Table 2) depicts the student enrollment, average number of graduates per year, and change in enrollment and graduates. For those persons interested in standard federal regional information, it is noted that the largest numbers of students are reflected in standard federal regions II, III and V, while the largest number of part-time students are found in regions III, VI and VIII. Regions II, VII and IX illustrate the largest numbers of graduates per annum. While Regions II and III report the majority of programs as illustrating an upward trend regarding enrollment and graduates, most of the regions are characterized by programs predominately defined as stable. One-third of the programs located in region IV which were surveyed and included in Wastewater Volume I, report a downward trend regarding enrollment and graduates although 56% of the programs are characterized as stable.

TABLE 2

WASTEWATER ENROLLMENT PROFILE SUMMARY

Degree	Enrollment Full-Time/Part-Time		Graduates Average # Per Year	Graduate-Enrollment Change By Program Up / Down / Stable		
	Full-Time	Part-Time		Up	Down	Stable
Certificate	0	80	80	0	0	1
Diploma	1	3	3	0	0	2
Associate	43	8	4	0	1	2
Bachelors	1921	63	27	10	3	9
Masters	1088	430	12	18	4	23
Doctoral	271	14	3	7	2	18
TOTAL	3324	598	129	35	10	55

C. Student Origin

Of the programs surveyed in Wastewater Volume II, the in-state student predominates. Enrollments of 50% or more of the students originating from in-state were reported by 62% of the programs. In-state enrollments of less than 50% characterized 22% of the programs, and information was not available for 16% of the program.

Enrollments of 50% or more of the students originating from out-of-state characterize 34% of the programs. Out-of-state enrollments of less than 50% included 47% of the program, and information was not available for the remaining 19%. Three factors seem to influence out-of-state enrollment:

1) lack of a reciprocal agreement between states regarding tuition adjustments for out-of-state students;
2) legislative parameters specifying the ration of in-state to out-of-state students; and,
3) proximity to neighboring states.

Overall 51% of the programs reported no foreign students. No figures were available for 14%, and the remaining 35% are characterized by enrollments which include from 3% to 66% of students originating from foreign countries. Most of these programs, however, reported the number of foreign students from 5% to 33%. One baccalaureate program indicated as few as 3%, and 66% was reported (within the same institution) as descriptive of a doctoral program. Of the total 27 states represented in this volume, 48% reported enrollments which included students originating from outside of the United States.

D. Employment

Tables3 details employment profiles in summary for the students referenced in the 58 programs included in Wastewater Volume II. The majority of graduates from the certificate, diploma, and associate degree programs acquire positions in government. These positions are usually at the local level as municipal wastewater treatment plant operators. Similarly, a number of these graduates move into the private sector primarily as industrial wastewater treatment plant operators.

At the baccalaureate, masters, and doctoral levels, the trend is toward employment in the private sector. Students graduating with the Bachelor's degree, however, enter governmental employment in regulatory or state agency roles. Consulting firms, mostly engineering, predominately employ graduates holding masters degrees. The doctoral graduates are fewer in number, and traditionally those (identified within the category "other" on the following table) obtain employment in postsecondary institutions in the areas of teaching or research.

At present, the student follow-up network does not readily provide for the categorization of the institution's graduates into distinct vocational roles. Although specific entry level positions are often known, most institutions limit their graduate occupational profiles to "government", "industry", and "consulting".

Graduate employment percentages are provided for all programs contained in Wastewater Volume II, in Table 8 (see Section III) in four categories: industry, consulting, government, and other. These figures were generated by program personnel as facts or as estimates. The column (Table 8) entitled "Graduate Follow-Up" is an indicator of reliability, i.e., if follow-up activities are not conducted by the program, the employment figures should be regarded as estimates that were provided by the program personnel.

Table 3 (following) presents employment data as compiled from Table 8, and illustrates a total graduate employment profile, in summary, for those programs depicted in Wastewater Volume II. Statistics for Table 3 were derived by multiplying the number of graduates per program, per year, by the percentage of graduates entering the four indicated categories. Actual numbers were totaled, and weighted percentages were then calculated. By relating the generalized percentages and number of graduates from Table 8, the percentages presented in Table 3 become reflective of the actual number of graduates reportedly entering the four categories of employment.

TABLE 3

WASTEWATER EMPLOYMENT SUMMARY

Degree	Private Sector Industry/Consulting		Total	Government	Other
Certificate	25%	2%	27%	73%	-
Diploma	30%	8%	38%	62%	-
Associate	34%	6%	40%	60%	-
Bachelors	39%	25%	64%	32%	4%
Masters	33%	28%	61%	34%	5%
Env. Eng.					
Doctoral	31%	27%	58%	22%	20%

E. Faculty

Table 8 indicates a total faculty of 478 of which 330 or 69% are full-time, and 148 or 31% are part-time. Although a student-faculty ratio can be developed, it would be less than meaningful for the following reasons:

1) some faculty members are engaged primarily in research;
2) a variety of departments supply faculty for occasional courses; and,
3) in addition to their regular course load, some faculty members teach an overload or additional courses.

F. Internship/Applied Study Terms

The internship and or applied study is a required component of 22% of the programs presented in Wastewater Volume II. In contrast, 78% of the programs do not, at present, have an applied study term or an internship.

G. Graduate Follow-up

The majority of the programs surveyed and presented in Wastewater Volume II employ some means of graduate follow-up. Approximately 68% of the programs responded that graduate employment activities were recorded for a period of one to five years. Those programs with no follow-up activities approximated 30%, while two percent were identified as information not available.

Personal contact and annual department mail surveys were among the most common means of tracking the activities of graduates. The placement offices, alumni associations and other organizations were also identified as useful tools for graduate follow-up.

II. ADDITIONAL FINDINGS

A. Recruitment Techniques in Wastewater Programs

Recruitment techniques appear as numerous as the programs themselves. The most widespread form of recruitment is by means of distribution of brochures or posters with tear-off cards. Programs at all levels find this to be a most effective method of advertising. It is impossible to determine the percentage of students that actually enroll in a particular program because of exposure to a brochure or poster. However, the majority of the contact people interviewed feel that the response, i.e., students requesting additional information about a program, is quite high.

In addition to brochures and posters, community colleges and technical schools actively solicit students through career orientation day programs, high school visitations, mass mailings to area high school teachers and even newspaper ads. These techniques of recruitment seem to be most effective with over 30% of the students enrolling in a program as a direct result of active recruitment. Personnel already employed in the wastewater field are also actively recruited for certification programs and upgrading seminars. Brochures are sent to state operator associations and other employment sites as well as direct mailing to operators.

Undergraduate recruitment closely parallels that of community colleges. Admission offices often send a representative to high schools and community colleges in order to recruit students for their institution rather than recruiting for a particular program. It is within the institution that students are recruited for the wastewater programs. The image of a program plays a strong role in attracting majors. Word of mouth by students is a very effective method of recruitment.

Graduate programs rarely have hardsell recruitment practices. Posters and brochures sent to undergraduate programs throughout the country are the major methods of recruitment. Some institutions send letters of invitation to outstanding graduates. Word of mouth and annual conventions are also an effective means of attracting students.

A majority of contact persons expressed concern with the difficulty of attracting well qualified undergraduate students to masters and doctoral programs because of the high salaries they receive from the private sector without an advanced degree. This is a particular problem with engineering programs.

B. Research Funding and Sources of Student Support

Research funding and student support play a vital role in the quality of education at the majority of institutions visited. Research money comes from a variety of sources both public and private. Federal agencies such as the Environmental Protection Agency, National Science Foundation, National Institute of Health and the Army Corps of Engineers support a substantial amount of research projects at most major universities. State and municipal agencies also contribute a significant amount of money for research activities at local institutions. Private industry research grants and private consulting contracts generate the majority of funding from the private sector although private foundations also support a small percentage of research projects.

Community colleges and technical schools traditionally receive very little research funding because they are training rather than research institutions. Occasionally EPA, a state or local agency will allocate funds for upgrading existing programs, community education, or further training for water or wastewater treatment plant operators already employed.

The majority of research grants and contracts are directed toward graduate level research and often support both faculty and graduate students. The Environmental Protection Agency is probably the single largest source of research funding. This includes the Office of Water Research and Technology, National Pollution Discharge System and the Federal Water Pollution Control Administration.

Student support is often dependent on the number of research grants a department has a a particular time. The majority of graduate students receive financial assistance in the form of research assistantships, teaching assistantships or graduate fellowships. EPA used to offer a large number of training grants for water and wastewater programs and some schools still receive such grants. The general opinion of persons interviewed is that the training grants should be reinstated in order to compete with the high salaries that undergraduates often receive. Students also support themselves by means of part-time employment or by student loans.

Undergraduate students in need of financial assistance often receive general financial aid packages which include university grants, basic educational opportunity grants, loans, and college work-study. Over 70% of students receive financial aid at private institutions while state supported universities are more affordable and undergraduate students are usually able to meet their financial responsibility.

C. Usuage of ERIC and IRIS

ERIC (Educational Resources Information Center) and IRIS (Instructional Resource Information System) are federally maintained computer retrieval systems encompassing educational resource materials on a national scale. IRIS is an EPA generated compilation of information pertaining to water and wastewater. Since the effectiveness of any such system can best be measured by its application and use, Phase II was appropriately expanded to include an adjunct assessment of the "utilization profile" of the educational community.

It should be pointed out that the respondents to the assessment question, "have you ever used ERIC or IRIS?", were faculty rather than students, and that the findings contained in Table 4 should be interpreted accordingly.

TABLE 4

ERIC/IRIS UTILIZATION PROFILE - WASTEWATER

	Yes	No	Total Responding
ERIC	11	35	46
IRIS	8	38	46

From a total of 46 responses, 23% have used ERIC and 17% have used IRIS. Use of these retrieval systems appears consistent throughout the country. In other words, use in one region is not significantly different from use in another. This volume mainly deals with graduate programs and ERIC appears more widely used in contrast to Water Volume I which contains a larger number of associate degree program personnel who would use IRIS. Because of the nature and type of information supplied, ERIC appears more applicable to graduate programs.

The following table depicts the use of ERIC and IRIS for all of the environmental areas surveyed and reported. Table 5 illustrates the total number of responses, therefore, as reflected in all of the volumes.

TABLE 5

ERIC/IRIS UTILIZATION PROFILE - NATIONAL SUMMARY

	Yes	No	Total Responding
ERIC	72	307	379
IRIS	64	314	378

Table 5 depicts the national summary responses regarding the utilization of ERIC and of IRIS. Nationally, of the 379 responses relative to the use of ERIC, 19% utilize the system, while 81% do not. Of the 378 responses regarding IRIS, 17% responded in the affirmative, and 83% reported that they do not use the IRIS system. From the above table, it may be noted that neither information retrieval system is widely utilized by the personnel interviewed.

D. Program Flexibility

The table following (Table 6) depicts the time required to implement a complete content change in a course, for all of the programs included in Wastewater Volume II.

TABLE 6

TIME REQUIRED TO IMPLEMENT A COMPLETE CONTENT CHANGE IN A COURSE

Degree Program	Less than 1 month	1 month-1 year	more than 1 year; less than 2	2-4 years	more than 4 years	Undetermined
Certificate	1	1	0	0	0	2
Diploma	1	0	0	0	0	2
Associate	3	2	0	0	0	2
Bachelors	7	12	0	0	0	4
Masters	6	24	2	0	0	9
Env. Eng.	0	0	0	0	0	0
Doctoral	3	20	2	0	0	9
TOTAL	21	68	4	0	0	28

In order for a program to be responsive to the changing needs of society, time constraints should not be a limiting factor. Table 6 addresses the time needed to implement a new course. The reader should refer to Appendix II "Terminology" for a definition of a Course change.

The majority (56%) of programs are able to make a course change within one month to one year. Community colleges, technical schools and private four-year institutions are for the most part able to implement course changes within one semester if additional funds or manpower is not needed. Course changes are usually made by departmental faculty. However, changes which must be approved outside of the department may take the better part of one year and in some cases two years.

State institutions are generally slow in implementing course changes due to the number of committees which must approve. Of the graduate programs represented in this volume 59% of the programs take from one to two years. Only 12% of the graduate programs are able to make a course change in one month or less. In most cases, the course is added as an experimental course and may take as long as two years before the course appears in the institution catalogue.

In contrast, 42% of the associate programs in the volume are able to implement a course change in less than one month. Because Associate degree programs are no longer than two years, rapid course implementation is a must. Of all the degree programs represented in this volume, 18% have the capability to implement a course change in less than one month. Generally a course can be added within one semester with 56% of the programs responding within one month to one year, 3% of the programs require one to two years and 23% of the programs were unable to determine the time needed to implement a course change.

TABLE 7

TIME REQUIRED TO IMPLEMENT A CHANGE IN A PROGRAM SEQUENCE

Degree Program	Less than 1 month	1 month-1 year	more than 1 year; less than 2	2-4 years	more than 4 years	Undetermined
Certificate	0	2	0	0	0	2
Diploma	0	1	0	0	0	2
Associate	1	3	1	0	0	2
Bachelors	3	9	4	2	0	5
Masters	2	20	6	1	0	12
Env. Eng.	0	0	0	0	0	0
Doctoral	0	19	4	1	0	10
TOTAL	6	54	15	4	0	33

Often times it becomes necessary for an education institution to change its curriculum by adding a new program or by changing a program sequence. Table 7 assesses the time needed to impelment a change in a program sequence. The reader is referred to the section "Terminology" for a definition of a program change.

Time constraints vary depending on the nature of the program. If additional faculty, funding or equipment are needed, the program, may take as long as five years before it receives approval. However, the majority of programs are able to implement a program change within one year. Programs replacing existing ones are usually implemented within one semester. State universities, for the most part have limitations on the number of faculty and students and therefore must replace, rather than add a program. Community colleges and technical schools, often time, must develop a complete curriculum befoe a new program can be offered. In such cases, approval of a program may take as long as two years. Of all the associate programs represented in this volume 14% require from one month to one year, and 43% require one to two years and 14% need only one month or less to implement a program change.

Of the 112 programs represented in this volume, 5% need less than one month to implement a program change, 48% require one month to one year, 13% require one to two years, 4% take as long as three to five years, and 30% are undetermined.

Generally, most schools can add a program within one year but it may take as long as three years to appear in the college catalogue. New programs at some institutions begin as experimental programs and it is only after the need is demonstrated that the program will become official. A new program may also be an out-growth of an existing program which has expanded its scope. Programs of this nature are usually more readily approved because the need and the faculty already exist.

E. Environmental Occupations

Occupations listed below are a result of the contact persons choice of 28 Water and Wastewater related occupations. In some cases the students are qualified for these positions but do not actually enter them. However, the majority of graduates are employed in occupations with job titles and discriptions similar to those detailed below. Of the programs represented in this volume at the certificate, diploma or Associate level the majority of graduate students are trained for the following occupations:

- Engineering Aide
- Industrial Waste Inspector
- Supervisor-Waterworking
- Water Analyst
- Water/Wastewater Treatment Operator
- Safety and Sanitary Inspector
- Superintendent-Water and Sewer Systems
- Water/Wastewater Equipment Technician

A Bachelors program, in most cases includes the above and in addition, the following occupations:

- Environmental Engineer
- Environmental Engineer-Water Pollution Control
- Sanitary Engineer
- Chemist
- Aquatic Biologist
- Environmental Engineer-Water Resources

At the graduate level most students find employment with private consulting firms or governmental agencies as Environmental Engineers. The majority of students enter the following:

- Environmental Engineer
- Environmental Engineer-Resources
- Water Resources Engineer
- Supervisor-Wastewater
- Water Pollution Control Biologist
- Environmental Engineer-Water Pollution Control
- Sanitary Engineer
- Superintendent-Water and Sewer Systems
- Health Physicist
- Ecologist

The reader is cautioned to remember that job descriptions vary from one level to the next. Therefore, an occupation may occur at both the Associate and graduate level such as "Superintendent-Water and Sewer Systems" but job responsibilities will differ.

Students of doctoral programs often enter University positions which was not listed as one of the occupational choices. Employment trends vary little throughout the regions.

Summarizing the occupation, demonstrates that graduates of less than four-year institutions usually find employment with a municipal or private water/wastewater treatment plant as operators. It is through promotion and continuing education that these people advance to higher level positions. Graduates of these programs have little difficulty finding employment.

Students with bachelors degrees often return to school for a masters degree after a few years of employment. Those employed with advanced degrees are predominantly products of Environmental Sanitary Engineering programs. The majority of graduates find employment in their field of study and have a great deal of lateral movement within.

III

A Summary Profile of Representative Educational Programs

The following footnotes (1-6) refer to the various column headings of the Table. Other footnotes are specific to the figures which were provided by various institutions and are used throughout the Table.

[1]Enrollment	1976-77 statistics
[2]Graduates	average for last three years; 'change' indicated apparent trends within that three-year period
[3]Employment	'other' includes positions such as those found within the educational community
[4]Faculty	full-time and part-time is determined by individual institutions
[5]Internship/Applied Study	part of an option to obtain a degree; may or may not have financial reimbursement connected with it
[6]Graduate Follow-up	a standardized procedure that enables the institution to periodically determine the employment of their graduates
NA	Not Applicable/Not Available
*Asterisk	denotes that a program appears in more than one volume of the profile

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1]		GRADUATES[2]	
				FULL TIME	PART TIME	No. / YEAR	CHANGE
CA	California State University-Sacramento	*Civil Engineering	B.S.	250	0	50	Stable
		*Environmental Engineering	M.S.	7	45	15	Stable
	Stanford University	*Environmental and Water Studies	M.S.	97	0	35	Stable
			Ph.D.	33	0	3	Stable
	University of California-Berkeley	*Sanitary Engineering	M.S.	20	0	15	Stable
			M.E.	5	0	2	Stable
			Ph.D.	15	0	5	Stable
CO	Colorado State University	*Environmental Engineering	M.S.	3	0	8	Down
			Ph.D.	3	0	1	Up
FL	University of Florida	*Water Supply and Water Pollution Control	M.E.	N/A	N/A	4	Down
			M.S.	103	0	22	Stable
			Ph.D.	15	0	6	Stable
			Engr.	0	0	0	Stable
IL	Illinois Institute of Technology	*Environmental Engineering	B.S.	43	25	15	Up
			M.S.	42	40	15	Stable
			Ph.D.	11	0		Stable

8

WASTEWATER EDUCATIONAL PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/ APPLIED STUDY[5]		GRADUATE FOLLOW-UP[6]	
	PRIVATE SECTOR									
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
95/5/NA	40%		40%	20%	25	0		X	X	
90/10/NA	40%		60%		7	0		X	X	
85/15/NA	60%	15%	25%		6	5		X	X	
85/15/NA	60%	15%	25%					X	X	
50/40/10		70%	25%	5%	8	0	X		X	
50/50/10		70%	25%	5%		0	X		X	
50/40/10	5%	60%	20%	15%		0	X		X	
30/70/NA	20%	80%			2	3		X		X
30/70/NA	20%	80%						X		X
40/60/NA	14%	25%	42%	19%	17	0		X	X	
40/60/NA	14%	25%	42%	19%		0		X	X	
40/60/NA	23%	24%	29%	24%		0		X	X	
40/60/NA	23%	24%	29%	24%		0		X	X	
50/50/NA	33%	33%	34%		6	4	X		X	
50/25/25	33%	33%	34%					X	X	
50/25/25	33%	33%	34%					X	X	

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1]		GRADUATES[2]	
				FULL TIME	PART TIME	No. / YEAR	CHANGE
IA	Iowa State University	*Sanitary Engineering	M.S.	22	0	9	Stable
		*Water Resources	M.S.	4	0	2	Stable
		*Sanitary Engineering	Ph.D.	7	0	0	Down
		*Water Resources	Ph.D.	4	0	1	Stable
KS	University of Kansas	*Water Resources Engineering & Science	M.S.	10	20	8	Stable
			Ph.D.	1	3	1	Stable
KY	University of Kentucky	*Environmental Engineering	M.S.	1	0	1	Down
			Ph.D.		0		Down
ME	University of Maine-Orono	*Sanitary Engineering	M.S.	14	0	5	Up
			Ph.D.	3	0	1	Up
MA	Harvard University	Environmental Sciences & Engineering	S.M.	2	0	2	Stable
			M.E.		0		Stable
			Ph.D.	25	0	6	Stable
	Massachusetts Institute of Technology	*Water Resources & Environmental Engineering	S.B.	27	0	10	Stable
			S.M.	40	0	28	Stable
			Sc.D./ Ph.D.	25	0	7	Stable

8

WASTEWATER EDUCATIONAL PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/[5] APPLIED STUDY		GRADUATE[6] FOLLOW-UP	
	PRIVATE SECTOR									
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
69/10/21	10%	50%	33%	7%	6	0		X	X	
69/10/21	33%		67%			0		X	X	
69/10/21	31%	23%	8%	38%		0		X	X	
69/10/21	31%	23%	8%	38%		0		X	X	
60/30/10		50%	50%		11	0		X	X	
75/25/NA		50%	50%			0		X	X	
50/50/NA	57%	3%	25%	15%	10	0	X		X	
50/50/NA	57%	3%	25%	15%		0	X		X	
NA/NA/NA	25%	50%	25%		5	0		X	X	
NA/NA/NA	25%	50%	25%			0		X	X	
NA/NA/NA		25%		75%	4	3		X		X
NA/NA/NA		25%		75%				X		X
NA/NA/NA		25%		75%				X	X	
NA/NA/33		80%	20%		11	0	X			X
NA/NA/33		80%	20%			0		X		X
NA/NA/33		33%		67%		0		X		X

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1]		GRADUATES[2]	
				FULL TIME	PART TIME	No. / YEAR	CHANGE
MA	Tufts University	*Environmental Health Engineering	B.S.C.E.	20	2	20	Down
			M.S.	24	2	12	Stable
MI	Michigan Technological University	*Environmental Engineering	B.S.E./ B.S.C.E.	135	0	30	Stable
			M.S.E.S.	18	0	11	Stable
MO	Missouri Southern State College	*Environmental Health	A.S.	6	0	1	Stable
			B.S.	17	0	6	Stable
	University of Missouri-Columbia	*Sanitary Engineering	B.S.	15	0	15	Up
			M.S.	12	0	10	Up
			Ph.D.	12	0	2	Up
	University of Missouri-Rolla	*Environmental & Sanitary Engineering	M.S.	13	35	N/A	N/A
			Ph.D.	1	0	N/A	N/A
NE	Central Technical Community College	*Environmental Technology	Cert.	0	80	80	Stable
			1 yr. Dipl.	0	3	3	Stable
			2 yr. Dipl.	1	0	2	Stable
			A.A.S.	7	0	5	Stable
			A.S.	0	0	0	Stable
	University of Nebraska	*Sanitary Engineering	B.S.	298	13	55	Up
			M.S.	9	6	9	Down

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WASTEWATER EDUCATIONAL PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/[5] APPLIED STUDY		GRADUATE[6] FOLLOW-UP	
	PRIVATE SECTOR									
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
NA/NA/NA	15%	30%	45%	10%	4	0		X		X
NA/NA/NA	15%	30%	45%	10%		0		X		X
87/13/0	25%	35%	40%		4	0		X	X	
87/13/0	25%	35%	40%			0		X	X	
80/15/5	25%	5%	70%		1	1		X	X	
80/15/5	20%	10%	70%					X	X	
90/5/5	25%	50%	25%		5	0		X		X
90/5/5	33%	33%	20%	14%		0		X		X
90/5/5	33%	33%	20%	14%		0		X		X
NA/NA/NA	50%		50%		7	0	N/A	N/A	X	
NA/NA/NA	50%		50%			0	N/A	N/A	X	
99/1/NA	30%	10%	60%		2	0		X	X	
99/1/NA	30%	10%	60%			0		X	X	
99/1/NA	30%	10%	60%			0	X		X	
99/1/NA	30%	10%	60%			0	X		X	
99/1/NA	30%	10%	60%			0	X	X		
72/8/20	20%	60%	20%		3	0	X		X	
80/10/10	20%	60%	20%			0		X	X	

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

				ENROLLMENT[1]		GRADUATES[2]	
STATE	INSTITUTION	PROGRAM	DEGREE	FULL TIME	PART TIME	No. / YEAR	CHANGE
NJ	Rutgers University	*Environmental Science	M.S.	70	60	40	Up
			Ph.D.	N/A	N/A	N/A	N/A
		*Environmental and Water Resources Engineering	M.S.	15	21	5	Up
			Ph.D.	1	0	1	Up
NY	Clarkson College	*Civil and Environmental Engineering Technology	B.S.	530	0	120	Up
			M.S.	20	5	12	Up
	Cornell University	*Environmental Engineering	B.S.	15	0	15	Down
			M.S.	18	0	15	N/A
			M.E.		0		N/A
			Ph.D.		0		N/A
	Rensselaer Polytechnic Institute	*Environmental Engineering	B.S.	20	0	25	N/A
			M.E./ M.S.	40	14	20	N/A
			Ph.D.	N/A	N/A	3	N/A
	State University of New York-Buffalo	*Water Resources & Environmental Engineering	B.S.	40	0	35	Up
			M.S.	22	23	10	Up
			Ph.D.	2	0	2	Stable
	Syracuse University	Chemical Engineering	B.S.	95	0	15	Stable
			M.S.	20	0	15	Stable
			Ph.D.		0		Stable

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WASTEWATER EDUCATIONAL PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY^4		INTERNSHIP/^{5} APPLIED STUDY		GRADUATE^6 FOLLOW-UP	
	PRIVATE SECTOR									
	INDUSTRY	CONSULTING	GOV'T	OTHER^3	FULL TIME	PART TIME	YES	NO	YES	NO
75/25/NA	35%		50%	15%	12	2	X			X
NA/NA/NA	35%		50%	15%				X		X
50/50/NA	67%		33%		5	0		X	X	
50/50/NA	67%		33%			0		X	X	
90/10/NA	60%		40%		21	1		X	X	
90/10/NA	60%		40%					X	X	
NA/NA/NA	80%		20%		5	0	X			X
NA/NA/NA	15%	75%	10%			0		X		X
NA/NA/NA	15%	75%	10%			0		X		X
NA/NA/NA	15%	75%	10%			0		X		X
20/80/NA	20%	60%	20%		5	6	X		X	
20/80/NA	20%	60%	20%					X	X	
20/80/NA	N/A	N/A	N/A	N/A			N/A	N/A	N/A	N/A
80/20/NA	20%	30%	50%		4	0		X	X	
67/33/NA	20%	30%	50%			0		X	X	
NA/NA/NA	20%	30%	50%			0		X	X	
60/40/NA	95%		5%		7	0		X		X
15/85/NA	95%		5%			0		X		X
15/85/NA	95%		5%			0		X		X

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

				ENROLLMENT[1]		GRADUATES[2]	
STATE	INSTITUTION	PROGRAM	DEGREE	FULL TIME	PART TIME	No. / YEAR	CHANGE
NY	Syracuse University	*Sanitary Engineering/ Science	M.S.	15	9	5	N/A
			Ph.D.			1	N/A
			M.S.			5	N/A
NC	University of North Carolina	Environmental Chemistry & Biology	M.S.	25	N/A	2	Stable
			M.S.P.H.		N/A	4	Stable
			Ph.D.	12	N/A	2	Stable
		*Water Resources Engineering	M.S.	15	N/A	N/A	Stable
			M.S.P.H.		N/A	N/A	Stable
			M.S.E.E.		N/A	11	Stable
			Ph.D.	3	N/A	1	Stable
OH	Ohio State University	*Civil Engineering	B.S.	35	3	32	Up
			M.S.	16	5	7	Up
			M.S./ P.A	0	2	1	Stable
			Ph.D.	4	1	1	Up
OR	Linn-Benton Community College	*Water/ Wastewater Operator	Cert.	12	0	12	Up
		*Water/ Wastewater	A.S.	22	0	15	Up
		*Wastewater	A.S.	13	0	12	Up

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WASTEWATER EDUCATIONAL PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/[5] APPLIED STUDY		GRADUATE[6] FOLLOW-UP	
	PRIVATE SECTOR INDUSTRY	PRIVATE SECTOR CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
15/85/NA	45%	45%	10%		10	3		X		X
15/85/NA	45%	45%	10%					X		X
15/85/NA	45%	45%	10%					X		X
30/65/5		50%	15%	35%	7	6		X	X	
30/65/5		50%	15%	35%				X	X	
30/65/5		50%	15%	35%				X	X	
21/58/21	5%	53%	18%	24%	4	8		X	X	
21/58/21	5%	53%	18%	24%				X	X	
21/58/21	5%	53%	18%	24%				X	X	
21/58/21		50%	50%					X	X	
80/17/3	20%	25%	40%	15%	7	0		X	X	
75/NA/25	20%	30%	40%	10%		0		X	X	
100/NA/NA		40%	60%			0	X		X	
34/NA/66	20%	20%	20%	40%		0		X	X	
95/5/NA	2%		98%		5	0	X		X	
95/5/NA	2%		98%			0	X		X	
95/5/NA	2%		98%			0	X		X	

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

				ENROLLMENT[1]		GRADUATES[2]	
STATE	INSTITUTION	PROGRAM	DEGREE	FULL TIME	PART TIME	No. / YEAR	CHANGE
OR	Oregon Institute of Technology	*Environmental Health Technology	A.A.S.	50	0	14	Up
			B.T.	27	0	7	Up
PA	Carnegie-Mellon University-Carnegie Institute of Technology	*Environmental Engineering	B.S.	N/A	N/A	34	Up
			M.S.	20	0	19	Up
			M.E.		0		Up
			Ph.D.	8	0	2	Stable
	Drexel University	*Environmental Engineering and Science	M.S.	69	36	15	Up
			M.E.			N/A	Up
			Ph.D.			4	Stable
	Pennsylvania State University	*Environmental Engineering	B.S.	127	3	23	Up
			M.S.	19	0	8	Up
			M.E.		0		Up
			Ph.D.		0		Up
		Minerals Processing	M.S.	22	0	2	Up
			Ph.D.		0		Up
	Temple University	*Environmental Technology/ Engineering Technology	A.T.	8	0	2	Down
			B.S.	64	12	15	Up
	University of Pittsburgh	*Environmental & Sanitary Engineering	B.S.	35	0	12	Up
			M.S.	30	30	35	Up
			Ph.D.	20	N/A	4	Stable

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WASTEWATER EDUCATIONAL PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/ APPLIED STUDY[5]		GRADUATE FOLLOW-UP[6]	
	PRIVATE SECTOR									
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
95/5/NA	95%		5%		9	0		X	X	
95/5/NA	95%		5%			0		X	X	
50/50/NA	40%	30%	30%		6	7		X	X	
20/62/18	40%	30%	30%					X	X	
20/62/18	40%	30%	30%					X	X	
20/62/18	40%	30%	30%					X	X	
50/50/NA	60%		40%		0	37		X	X	
50/50/NA	60%		40%		0			X	X	
50/50/NA	60%		40%		0			X	X	
90/10/NA	25%	45%	30%		10	N/A	X		X	
50/50/NA	25%	45%	30%		6	N/A		X		X
50/50/NA	25%	45%	30%			N/A		X		X
50/50/NA	25%	45%	30%			N/A		X		X
NA/NA/NA	70%	20%		10%	3	0		X	X	
NA/NA/NA	70%	20%		10%		0		X	X	
80/20/NA	40%	40%	20%		2	N/A	X		X	
80/20/NA	40%	40%	20%			N/A	X		X	
95/5/NA	30%	50%	20%		8	0		X	X	
60/20/20	30%	50%	20%			0		X	X	
60/20/20	30%	50%	20%			0		X	X	

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

				ENROLLMENT[1]		GRADUATES[2]	
STATE	INSTITUTION	PROGRAM	DEGREE	FULL TIME	PART TIME	No. / YEAR	CHANGE
RI	University of Rhode Island	*Environmental Engineering	B.S.	N/A	N/A	10	Stable
			M.S.	7	4	5	Up
			Ph.D.	N/A	N/A	1	Stable
TN	University of Tennessee	*Water Pollution Control/ Water Resources	M.S.E.E.	15	21	16	Stable
			M.E.				Stable
			Ph.D.	10	0	2	Down
	Vanderbilt University	*Water and Wastewater Treatment Water Resources	M.S.	16	0	6	Stable
			M.E.	6	0	2	UP
			Ph.D.	10	0	2	Down
TX	University of Texas-Austin	*Water Resources Engineering	M.S.	7	4	5	Stable
			Ph.D.	5	2	2	Stable
		*Environmental Health Engineering	M.S.	32	15	25	Stable
			Ph.D.	10	3	3	Stable
UT	Brigham Young University	*Water Resources and Environmental Engineering	B.S.	15	0	15	Stable
			M.S.	17	6	4	Stable
	Utah State University	*Civil and Environmental Engineering	B.S.	79	5	N/A	Stable
			M.S.	18	3	23	Up
			Ph.D.	17	0	11	Up

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WASTEWATER EDUCATIONAL PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT PRIVATE SECTOR				FACULTY[4]		INTERNSHIP/[5] APPLIED STUDY		GRADUATE[6] FOLLOW-UP	
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
NA/NA/NA	75%		25%		3	0		X		X
NA/NA/NA	75%		25%			0		X		X
NA/NA/NA	75%		25%			0		X		X
60/35/5	21%	23%	43%	13%	7	0		X	X	
60/35/5	21%	23%	43%	13%		0		X	X	
60/35/5	21%	23%	43%	13%		0		X	X	
10/90/NA	25%		75%		8	0		X		X
10/90/NA	25%		75%			0		X		X
10/90/NA	25%		75%			0		X		X
50/50/NA	20%	35%	35%	10%	7	2		X	X	
60/40/NA	20%	35%	35%	10%				X	X	
50/50/NA	20%	35%	35%	10%				X	X	
50/50/NA	20%	35%	35%	10%				X	X	
50/50/NA	50%		25%	25%	4	0		X		X
50/50/NA	50%	10%	25%	15%		0		X		X
30/40/30	50%	20%	30%		7	0		X	X	
10/76/14	50%	20%	30%			0		X	X	
10/90/NA	40%	30%		30%		0		X	X	

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1]		GRADUATES[2]	
				FULL TIME	PART TIME	No. / YEAR	CHANGE
VA	J. Sargeant Reynolds Community College	*Environmental Technology	Cert.	0	296	N/A	N/A
			A.A.S.	9	8	3	Stable
	Virginia Polytechnic Institute	*Sanitary Engineering	M.S.	15	3	15	Stable
			M.S.	15	2	15	Stable
			M.S.	5	0	3	Stable
			Ph.D.	4	0	2	Stable
			Ph.D.	4	0	2	Stable
	Wytheville Community College	*Environmental Technology	Cert.	11	6	13	Stable
			Dipl.	2	0	1	Stable
			A.A.S.	13	0	6	Stable
WI	Marquette University	*Environmental Engineering	B.S.	61	0	15	Down
			M.S.	10	26	6	Stable
	University of Wisconsin-Madison	*Water Resources Management	M.S.	72	0	20	N/A
		*Environmental Monitoring	M.S.	7	0	N/A	N/A
			Ph.D.	7	0	N/A	N/A
		*Land Resources	M.S.	21	0	N/A	N/A
			Ph.D.	14	0	N/A	N/A

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WASTEWATER EDUCATIONAL PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/ APPLIED STUDY[5]		GRADUATE FOLLOW-UP[6]	
	PRIVATE SECTOR INDUSTRY	PRIVATE SECTOR CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
96/4/NA	25%		75%		1	1		X	X	
100/NA/NA	50%		50%			0	X		X	
60/40/NA	25%	25%	40%	10%	7	6		X		X
60/40/NA	25%	25%	40%	10%				X		X
60/40/NA	25%	25%	40%	10%				X		X
60/40/NA	25%	25%	40%	10%				X		X
60/40/NA	25%	25%	40%	10%				X		X
99/1/NA	25%		75%		2	1	X		X	
99/1/NA	25%		75%				X		X	
99/1/NA	25%		75%				X		X	
50/40/10	15%	60%	20%	5%	4	0		X		X
50/20/30	15%	60%	20%	5%		0		X		X
70/25/5	50%		50%		0	52	X		X	
70/25/5	50%		50%		0		X		X	
70/25/5	50%		50%		0		X		X	
70/25/5	50%		50%		0		X		X	
70/25/5	50%		50%		0		X		X	

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Michigan Technological
University Catalog 1975-76

PROJECT COMMENTARY

Photo reprinted from the
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Columbia Bulletin 1977

PROJECT CONSTRAINTS

In preparation for the on-site interviews, all of the institutions' catalogs were intensively reviewed in order to determine where environmental programs were being offered. During the course of this study, 171 institutions were visited and a total of 338 environmental programs, representing 45 states and Washington, D.C., were surveyed in detail. Albeit significant, these programs represent only a portion of all such programs available and cannot be construed as an in-depth survey of all environmental programs. It is, however, a representative sample within each of the environmental pollution control areas of Air, Noise, Pesticides, Radiation, Water and Wastewater, Solid Waste and Energy.

Several constraining factors to the proposed comprehensiveness of the study were encountered while collecting data from the institutions. It was disappointing to find that definitive records or statistics were generally unavailable which would describe specifically the placement of environmental program graduates. General indications of placement within categories, such as government or industry, were often available in percentages only. Depending on the size of the program and its age, some contact people could describe all graduates, others knew only where the past year's graduates were presently employed, and still others were aware only of their advisees entry-level positions and subsequent moves.

It also became clear during the on-site interviews that some programs of similar or identical content had different titles. This lack of clarity within the environmental areas serves to confuse the casual reader. For that reason, attention must be directed to the actual environmental course listings included in each program summary.

A list of terms commonly used during the on-site interviews and subsequently in this report was developed in order to facilitate precise data gathering. The reader is directed to Appendix II, TERMINOLOGY.

No attempt was made, in this report, to qualitatively judge any of these programs. The apparent absence of substantial qualitative measures in the environmental education field in general and the desire to collect data in a neutral atmosphere underscore the reasons for this omission. It appears that there is a need for the development of an environmental program model in each of these areas in order that some qualitative standards be provided where none now exist.

COMMENTARY

Postsecondary educational programs representative of wastewater training across the United States are presented in Wastewater Volume II. The information contained, herein, is not inclusive of all states, although wastewater programs are being conducted in all states at academic levels ranging from certification to doctoral and professional degrees.

Wastewater Volume II presents an overview of postsecondary environmental programs offering multiple degrees. The information contained in this volume represents 58 programs from 24 states and include 3,922 full-time and part-time students. The majority of the programs herein presented offering multiple degrees are at the graduate level. For a more complete presentation of the wastewater training programs, the reader is encouraged to refer to Wastewater Volume I.

Table 3 shows that 75% of the graduates from certificate programs are employed by the governmental sector. Baccalaureate, master's and doctoral graduates are more often employed in the private sector. This national trend may be attributed to higher entry-level salaries and more active recruitment of graduates, by the private sector, on college and university campuses.

Environmental and sanitary engineering programs represent the majority of the wastewater training programs. The reader will note many similarities among programs because of this fact.

Recruiting techniques are fairly standard and common to most of the educational institutions depicted in this volume. Brochures, posters and letters to other universities are representative of recruiting techniques at the graduate level. In general undergraduate, community colleges and technical schools utilize more intense recruitment efforts such as regular visitations to high schools.

Overall, the environmental programs maintain a favorable and positive image within the institutions. Occasional expressions of concern regarding the maintenance of high standards were noted by the more rigorous and traditional schools of engineering when questioned about environmental programs. The absence of emphasis on the sciences was a concern experssed by engineering personnel. Many of the educators interviewed noted the lack of skills regarding financial management and communication skills. Within the last few years, many institutions have begun to offer course work in these areas in response to the growing awareness for the need for increased capabilities.

Hands-on-experience, applied study terms and internships are receiving increasing attention by the educators who were interviewed. Many of the program personnel favor this type of activity as an additional requirement. At present, however, the majority of the programs do not define the internship or applied study term as a required program component. Many of the graduate students are involved in research activities which often include practical and/or applied experiences. Community colleges and technical schools normally require a certain amount of hands-on experience within the actual plant environment.

Many of the faculty members represented within the programs of this volume enjoy prestigeous reputations in their fields. The majority are involved in extensive research and consulting activities.

A large number of the faculty interviewed maintain close relationships with the students. This is noted through the interviews and is manifested by the high incidence of graduate follow-up. Graduate follow-up activities are varied as depicted through interviews with program personnel.

The future of environmental programs is one of cautious optimism among the educators. However, the majority of educators forecast a bright future for those in the field. The needs and interests are demonstrated. Federal funding, however, vacilates from periodic highs to periodic lows. Due to federal legislation, workforce demands are increasing. In response to the needs for an increased workforce it is noted that only 7% of the programs presented in this volume are characterized by declining enrollment. The majority of the programs are reported as stable, currently, and program personnel anticipate a continuation of this trend over the next three to five years. Increasing enrollments and graduates were reported by 30% of the programs.

There is a growing concern among educators regarding the recruitment of students for graduate programs. The availability of U.S. EPA training grants for student support has declined. This factor, in conjunction with the comparatively high salaries offered to baccalaureate students, tends to inhibit enrollment in graduate programs. The overwhelming majority of program personnel favored substantial increases in both availability and dollar amounts of these grants. Overall, increased federal funding allocations could play an important role in improving and maintaining the quality of our environment, through the support of high caliber training and education directed to meet the nation's future manpower needs.

LIST OF WASTEWATER

TRAINING INSTITUTIONS

BY DEGREE

Photo reprinted from the Indiana University School of Public and Environmental Affairs Catalog 1977-78

WASTEWATER

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WASTEWATER TRAINING SUMMARIES

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SECTION I - CERTIFICATE, DIPLOMA & ASSOCIATE DEGREE PROGRAMS

- Central Technical Community College
- J. Sargent Reynolds Community College
- Linn-Benton Community College
- Wytheville Community College

INSTITUTION: CENTRAL TECHNICAL COMMUNITY COLLEGE (CTCC)

PROGRAM: Environmental Technology

DEPARTMENT: Environmental Technology

DEGREE: Associate of Applied Science   Two-Year Diploma
Associate of Science   One-Year Diploma
Certificate of Achievement
(Wastewater Treatment Plant Operators)

CONTACT: Mr. Dean Blaha, Chairman
Agriculture/Environmental Technology Division
Central Technical Community College
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Hastings, Nebraska 68901
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PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Environmental Technology program was organized in 1971-72 under a $70,000 EPA grant and provides training for laboratory assistants seeking work in testing labs, small and large industrial plants, experimentation stations, pollution monitoring agencies, and municipalities. Employment possibilities are extensive for graduates of this technically and vocationally oriented program (e.g., environmental engineers, water and wastewater treatment plant operators and technicians, radiation monitors). Faculty members note, however, that Nebraska's job market, particularly in the smaller communities, cannot financially attract and hold CTCC graduates with extensive certification.

Currently the program in Environmental Technology remains active due to enrollment in basic laboratory courses by students from other programs on campus. Staff members also conduct numerous certification classes both on and off campus for water and wastewater treatment plant operators. An EPA laboratory van on loan to the school facilitates some field training, but its size limits the number of people trained at one time. Students have access to the local water and wastewater treatment plant as well as the standard laboratory facilities at CTCC (including a mass spectrophotometer).

PROGRAM REQUIREMENTS

Central Technical Community College operates on an open enrollment plan which enables any student with a high school diploma or equivalent to register for courses any day school is in session. Consequently, instruction is highly individualized, flexible, and self-paced. The unique enrollment plan attracts numerous visitors from other post-secondary institutions who want to assess its advantages and disadvantages.

Degree requirements vary depending on the program level and are summarized as follows:

Associate of Applied Science

43 qtr. hours, major occupational area
9 qtr. hours, related occupational area
12 qtr. hours, optional occupational area
30 qtr. hours, general education

94 qtr. hours required

Associate of Science

47 qtr. hours, occupational area
47 qtr. hours, general education

94 qtr. hours required

Two-Year Diploma

60 qtr. hours, major occupational area
7 qtr. hours, related occupational area
12 qtr. hours, optional occupational area
15 qtr. hours, general education

94 qtr. hours required

One-Year Diploma

39 qtr. hours, major occupational area
9 qtr. hours, general education

48 qtr. hours required

CTCC participates in the Federally Insured Student Loan Program, the College Work-Study Program, and the Basic Educational Opportunity Grant Program. Students may also earn part of their college expenses through work at the school. Some scholarships are available.

CURRENT FACULTY, STUDENTS, GRADUATES

Two full-time teaching faculty paid by the college instruct eight full-time (three female) and 83 part-time students in Environmental Technology. Almost all CTCC students are residents of Nebraska. The program does not attract career-change students. Average numbers of graduates per year vary with the degree obtained: five Associate; two Two-Year; three One-Year Diplomas; eighty Certificates. These figures should increase with the establishment of EPA certification requirements.

Successful recruitment of students stems primarily from state-level agency referrals and from former students. Placement figures from a 1975-76 report indicate that 71 percent of the seven graduates that year took jobs, all in their area of training. Approximately 40 percent of Environmental Technology graduates locate in the private sector while 60 percent obtain employment in government or municipal offices. Faculty contacts with prospective employers are viewed as excellent means of placement, and available jobs outnumber available graduates by a five-to-one ratio.

PROGRAM PROJECTIONS

Development of the Environmental Technology program depends on the direction taken by state and federal agencies. With higher EPA certification requirements and the possible designation of CTCC as a state training center in wastewater treatment, the program will undoubtedly expand. The cost of training municipal employees may mandate additional EPA training monies either to the colleges or to the communities served. The lack of student familiarity with the technical career possibilities in environmental areas and the negative connotations associated with water and wastewater coursework serve, according to the faculty, to keep enrollment in this program low.

COURSE DESCRIPTION

650.05 Introduction to Environmental Treatment - An introduction to the field of wastewater treatment. (3 q.h.)

650.10 Environmental Control Transport & Hydraulics Systems - Water distribution and collection. (5 q.h.)

650.15 The Wastewater Treatment Facility - A comprehensive study of the wastewater treatment plant units. (12 q.h.)

650.17 Biological Processes of Wastewater Treatment - The study of biological treatment of wastewater. (8 q.h.)

650.30* Plant Control Procedures - Routine laboratory and operational procedures and calculations pertinent to maintaining good water quality standards. (9 q.h.)

650.40* Chemical Analysis - Includes pH determination, acidity, alkalinity, dissolved oxygen, solids and digester analysis. (4 q.h.)

650 41* Introduction to Atomic Absorption - Introduction to technology and operation techniques for operating an atomic absorption instrument. (8 q.h.)

650.42* Pesticide Analysis - The analyzing of soils and water for pesticides. (4 q.h.)

650.43* Heavy Metal Analysis - The preparation and analysis of soil, plants, water and waste materials for various heavy metals. (6 q.h.)

650.44* Wet Chemistry - The course covers analysis of substances in waste. (6 q.h.)

650.45* Wastewater Microbiology - Counting and identification of indicator organisms stressing aseptic techniques and procedures for confirmation of presumptive tests. (6 q.h.)

650.46* Wastewater Chemical Analysis IV - Includes procedures for heavy metal determinations and test procedures for phenols and greases. (3 q.h.)

650.47* Wastewater Chemical Analysis II - Includes chemical analysis making use of colormeter and spectrophotometer. (5 q.h.)

650.48* Wastewater Chemical Analysis III - Covers chemical oxygen demand and biological oxygen demand determinations. (3 q.h.)

650.55* Water Pollution Ecology - A lab study in the biology of a stream with regard to indicator organisms. (3 q.h.)

650.60* Field Lab Procedures - Sampling techniques and lab procedures in the field. (3 q.h.)

650.70 Calculations for the Wastewater Treatment Technician - Mastery of the mathematics attendant to a wastewater treatment plant. (1 q.h.)

650.75 The Natural Purification Cycle - An understanding of the natural processes involved in natural stream purification. (1 q.h.)

650.80 Plant Operator Certification Review - Preview and pretesting for the State of Nebraska operator's certificate. Awarding of course hours contingent upon certification desired. (6 q.h.)

650.90 Occupational Problems - Research projects and special studies are individually planned. (12 q.h.)

650.93 Independent Study - A course designed by the student and the instructor/advisor to meet unique educational objectives in Environmental Technology. (5 q.h.)

*technical course

INSTITUTION: J. SARGEANT REYNOLDS COMMUNITY COLLEGE

PROGRAM: Environmental Technology-Environmental Operations

DEPARTMENT: Engineering/Engineering Technology

DEGREE: Associate in Applied Science
Certificate in Environmental Operations

CONTACT: Roger A. Cooley
Engineering/Engineering Technology
J. Sargeant Reynolds Community College
P.O. Box 12084
Richmond, Virginia 23241
(804) 264-2792

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The environmental technology and environmental operations programs are designed to train technical personnel in various areas of environmental control, primarily water and air.

Environmental technology was initiated in 1974 and offers an associate in applied science degree with the opportunity to specialize in environmental engineering technology or environmental health technology. This two-year program prepares students for careers as an air pollution control technician, public health engineering aide, sanitarian, wastewater plant operator/supervisor, design assistant, stream sanitation technician, industrial waste technician, or water plant operator/supervisor.

The environmental operations program began in 1976 and is operated in cooperation with the Virginia State Water Control Board. The program leads to an environmental operations specialist certificate which qualifies students as wastewater treatment plant operators. It is also designed to allow interested students to continue their training in the environmental technology program described above. This program is four quarters in length and normally requires at least one year for completion. The program is headquartered at the J. Sargeant Reynolds campus and taught at fifteen community colleges in Virginia.

PROGRAM REQUIREMENTS

Admission requirements for the environmental technology program include the college entry requirements which are a high school diploma or its equivalent or at least eighteen years of age and able to benefit from a course of study. Also required as a minimum are the completion of four units of high school English or equivalent, two units of math, one unit of laboratory science, and one unit of social studies. Students applying for the environmental operations are required only to meet the admission requirements of the college.

A minimum of one hundred and seven to one hundred and eight quarter credits are required for the engineering or health specializations in environmental technology. All students in this program are required to take basic courses in public health, sanitary biology and chemistry, technical writing, introduction to air pollution, and introduction to water and wastewater treatment technology.

The environmental operations program is offered in modular form, with each course given in one-credit modules of fifteen to twenty clock hours each. Courses require one to five modules for completion. This format allows students to complete the program while employed without long absences from work. Generally, prerequisites are not required and students can enroll in modules of their choice without regard to sequence. This program was designed in conjunction with the Virginia State Water Control Board and the modules are offered at several community colleges throughout the state. A minimum of fifty-five credits are required for the certificate, with about fifteen percent of these in general education and the remainder in environmental control and technician support areas.

CURRENT FACULTY, STUDENTS, GRADUATES

Currently the faculty consists of one full-time and one part-time member. All faculty time is devoted to teaching. The part-time faculty member teaches the environmental operations program and is employed by the Virginia State Water Control Board.

In the environmental technology program, there are currently nine full-time and eight part-time students. All are Virginia residents and all the part-time students are currently employed in the environmental field. The program attracts a significant number of career change students and upwardly mobile wastewater treatment plant operators. Most students are recruited through informal contact with other students or faculty. A limited amount of recruiting is done in high schools. Few students in this program are currently receiving any financial aid.

The environmental operations program has a current enrollment of two hundred and ninety six part-time students. However, this figure includes students registered for course modules in fifteen community colleges throughout Virginia. All these students are presently working in water and wastewater plants and almost all are Virginia residents. Recruitment for this program is not a problem since students are already working in wastewater plants. About ninety-five percent of the students receive financial assistance through employer paid salary plus tuition and travel.

The environmental technology program graduates approximately three students per year, which has remained stable since the program began. No figures are available for the environmental operations program since it just began in 1974. Job placement is not a problem for either program since the overwhelming majority of students are already employed. It is estimated that about fifty percent of the environmental technology graduates work in government jobs, primarily at the local level, and the other fifty percent go into private industry. Again, figures are not available for the environmental operations program.

PROGRAM PROJECTIONS

Program officials hope to be able to expand both programs within the next two or three years. With regard to the environmental technology program, it is anticipated that more courses would be offered and possibly a certificate program added primarily for evening students. Officials see the expansion of the environmental operations program to include a certificate in water supply. It is estimated that this expansion may require one additional full-time faculty member for environmental technology and three part-time faculty for environmental operations.

ADDITIONAL INFORMATION

Short courses and workshops are also presented by the faculty of this program for the Virginia Health Department, the State Water Control Board, consulting engineers, and utility companies.

COURSE DESCRIPTION

(the following is a partial listing of courses)

CIVL 260 Hydraulics - Principles of fluid flow and development of practical hydraulics resulting from study of fluid statics, flow of real fluid in pipes, multiple lines, liquid flow in open channels, and fluid measurement techniques. (3 q.h.)

ENVR 110 Introduction to Water and Wastewater Treatment Technology - Designed to provide entry level personnel with a general overview of the entire water supply and treatment system. Historical and legal aspects of water supply and waste disposal together with basic aspects of public relations for water and wastewater treatment plant personnel. (3 q.h.)

ENVR 120 Introduction to Air Pollution - Air pollution in relation to public health; study of the scientific, engineering, and legal aspects of pollution; sources and classification of pollutants, pollution meteorology; remedies and controls currently available; and other topics. (3 q.h.)

ENVR 124-125 Water Purification - Principles of water purification including: secretion, sedimentation, rapid sand filtration, chlorination, treatment chemicals, taste and odor control, bacteriological control, mineral control, design criteria, maintenance programs, and operation forms and records. (2 q.h.)

ENVR 166 Wastewater Treatment Plant Operation - Environmental principles and practices and desired function and operation of a variety of wastewater treatment unit processes. (5 q.h.)

ENVR 168 Wastewater Treatment Plant Control - Analytical and control procedures required in the operation of the unit processes which will be used in wastewater treatment plants. (4 q.h.)

ENVR 211-212-213 Sanitation Biology and Chemistry - Theory and laboratory technique for all control tests of water purifications including: bacteriology, color, turbidity, pH, alkalinity, hardness coagulation, chlorides, fluorides, iron, manganese, detergents, bactericides, and nitrates; "in-plant studies at nearby plants"; also a study of the theory and laboratory techniques for the determination of solids, dissolved oxygen, oxygen consumed, relative stability, bacteria, bio-chemical oxygen demand, organic nitrogen, volatile acids, toxic metals. (3 q.h.)

ENVR 216 Water Supply and Wastewater Collection - The engineering aspects of water supply, water distribution, waste water collections and waste water removal and disposal. (3 q.h.)

ENVR 218 Industrial Waste Treatment - Principles and methods of contemporary industrial waste treatment; relationships between the characteristics of industrial wastes and their effects on receiving waters. (3 q.h.)

HLTH 111-112-113 Public Health I-II-III - Public Health administration, environmental sanitation and control both urban and rural, food and milk sanitation, radiological health, sanitary limnology, control of communicable diseases. (2 q.h.)

HLTH 280 Solid Waste Management - An introductory course in the processes of solid waste management and vector control emphasizing the collection and disposal of solid wastes and vector-associated health problems. (3 q.h.)

INSTITUTION: LINN-BENTON COMMUNITY COLLEGE

PROGRAM: Water/Wastewater Technology

DEPARTMENT: Science and Technology

DEGREE: Certificate, Water/Wastewater Operator; Associate of Science (A.S.), Water/Wastewater Technology, or, Wastewater Technology

CONTACT:
Dr. Peter Scott
Director of the Science/Technology Division
Water/Wastewater Technology Department
Linn-Benton Community College
6500 S.W. Pacific Blvd.
Albany, Oregon 97321
(503) 928-2361

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Water/wastewater technology is a three pronged program at Linn-Benton Community College. Established in 1969, the program has undergone some revisions and growth since inception. Today, the three programs include wastewater technology, water/wastewater technology and water/wastewater plant operator. The first two programs are similar. The wastewater program prepares students for employment in the field of wastewater. The water and wastewater program prepares students for jobs either in wastewater or in potable water. Both of these programs are two-year technician level programs which lead to the Associate of Science degree.

The third program, water/wastewater plant operator, is a relatively new addition to the wastewater technology curricula. Instituted in 1976, this program prepares students for certification as water and wastewater treatment plant operators, and is a one-year program.

PROGRAM REQUIREMENTS

The only requirement for admission to Linn-Benton is that applicants be beyond 18 years old or have completed high school or its equivalent.

The wastewater technology and the water/wastewater technology programs are similar. The first year's requirements are common to both programs and include: microbiology, basic aquatic chemistry, math and occupational writing = 31 quarter hours; and four water and wastewater courses = 15 quarter hours.

During the summer between the third and fifth quarters there is an in-plant practicum for which the student earns 16 quarter hours.

The second year, course requirements are as follows: courses common to both programs: process interaction; aquatic chemistry; wastewater mechanics; applied hydraulics; technical project; management; elements of supervision and, physical education. In addition to the common course work, the second year wastewater student will take 17 quarter hours of approved electives and advanced waste treatment (one course).

The requirements other than those outlined above as common to both programs, for the water/wastewater student are: water sources; water purification systems; waste distribution; and, 10 quarter hours of technical electives.

The requirements for completion of the one-year certificate program, water/wastewater plant operator, differ from those of the two-year programs. The program begins in the winter and lasts four quarters. The following details this program:

Course	Quarter: W	S	S	F
Water/Wastewater Treatment Plant Operator I, II, III	10	10		10
Math II and III	4	4		
In-Plant Practicum			16	
Communications				3
American Institutions		3		
Developmental Reading	3			
First Aid				3
	17	17	16	16

Suggested technical electives include: Advanced Aquatic Chemistry, Basic Protozoology, Ecology, Aquatic Biology, Technical Math III, Computer Programming, Instrumental Analysis, Blueprint Reading, Welding, Surveying, General Electricity, and Machine Processes.

CURRENT FACULTY, STUDENTS, GRADUATES

Current faculty allocated to the water/wastewater technology program totals five full-time faculty members. All five are cost-centered.

Enrollment in these programs include 47 students. They are distributed across the three programs in the following manner.

	Students		
Program	Male	Female	Total
One-Year Certificate	10	2	12
A.S. Wastewater	11	2	13
A.S. Water/Wastewater	20	2	22

Graduates average 12 per annum at the certificate level; approximately 12 annually receive the associate degree in wastewater; and, approximately, 15 are graduated with the associate degree from the water/wastewater program. Historically, these students elect a career path upon completion of these programs. Employment opportunities are excellent, and students graduating from these programs acquire jobs immediately upon completion of their studies. They are enployed by the public sector, predominantly.

PROGRAM PROJECTIONS

The Linn-Benton water/wastewater technology programs are well known nationally. Graduates are highly employable, and all indications are in the direction of growth and expansion. The faculty is anticipating an increase of one within the next two years. No new programs are planned at this time. Rather the administration and the faculty will continue to revise and up-grade curriculum offerings commensurate with the programs outstanding reputation of excellence in the field.

COURSE DESCRIPTION (selected)

WT 6.114 Aquatic Microbiology - A basic course in water microbiology with emphasis on microorganisms found in surface and wastewater. (4 q.h.)

WT 6.151 Collection and Pre-Treatment - This course is an introduction to the wastewater treatment system, its process, and the identification of its subsystems and processes. (4 q.h.)

WT 6.152 Primary/Secondary Sedimentation/Digester Operation Control Processes - This course deals with primary and secondary clarifiers and the equipment used in sludge removal. (4 q.h.)

WT 6.153 Introduction to Activated Sludge and Trickling Filters - This course develops an understanding of the operation of activated sludge and trickling filter treatment plant processes. (4 q.h.)

WT 6.154 Process Interaction - This course deals with wastewater treatment process interaction and total systems design. (4 q.h.)

WT 6.155 Advanced Waste Treatment - Introduction to the methods of advanced waste treatment which includes physical-chemical treatment process, reverse osmosis and flash evaportation. (4 q.h.)

WT 6.161 Water/Wastewater Management - Orders for supplies, service and parts, operational reports, annual budgets, as well as list manpower requirements and needed capital improvements in the operation of a water/wastewater facility. (3 q.h.)

WT 6.163 Introduction to Potable Water Systems - A general view of potable water systems includes: water needs and uses. (4 q.h.)

WT 6.164 Water Sources - The study of surface water sources. (4 q.h.)

WT 6.165 Water Distribution - A basic course of study in the techniques of installation, operation, maintenance of water distribution systems. (4 q.h.)

WT 6.166 Water Purification Systems - The study of theory and operation of water purification. (4 q.h.)

WT 6.180 Wastewater Mechanics I - This course of study will include equipment used in a treatment plant. (3 q.h.)

WT 6.181 Wastewater Mechanics II - This course will include setting up parts inventory and extensive preventive maintenance file systems. (2 q.h.)

WT 6.185 Water/Wastewater Treatment Plant Operator I - Introduction to water and wastewater treatment plant operation. (10 q.h.)

WT 6.186 Water/Wastewater Treatment Plant Operator II - Water purification processes and secondary waste treatment processes. (10 q.h.)

WT 6.187 Water/Wastewater Treatment Plant Operator III - Treatment plant process interaction. (10 q.h.)

WT 9.650 Water Treatment - A general discussion of the needs and uses of water. (3 q.h.)

WT 9.651 Water Sources - A study of the location, development and operation of both ground and surface water sources. (3 q.h.)

WT 9.652 Water Treatment Facilities - A study of the theory, operation, and maintenance of water treatment facilities. (3 q.h.)

WT 9.654 Disinfection and Flouridation - A study of the theory of disinfection. (3 q.h.)

WT 9.655 Special Water Treatment - The operational theory of special treatment techniques. (3 q.h.)

WT 9.656 Wastewater Treatment - The history of treatment, the laws and agencies involved in wastewater treatment, the construction, operation, and maintenance of sanitary sewage collection systems. (3 q.h.)

WT 9.657 Primary Treatment - The theory, operation and maintenance of low measurement devices, grit, grinding and removal, primary sedimentation, and anaerobic digesters. (3 q.h.)

WT 9.658 Secondary Treatment I - The theory, operation and maintenance of sewage lagoons and trickling filters. (3 q.h.)

WT 9.659 Secondary Treatment II - The theory, operation and maintenance of the activated sludge sewage treatment process. (3 q.h.)

WT 9.660 Advanced Waste Treatment - Advanced waste treatment systems. (3 q.h.)

WT 9.661 Management of Water & Wastewater Systems - The types of governmental entities that operate water and wastewater systems. (3 q.h.)

WT 9.663 Sludge Handling - Various systems of concentrating, conditioning, and disposing of sewage sludge and solids. (3 q.h.)

INSTITUTION: WYTHEVILLE COMMUNITY COLLEGE

PROGRAM: Environmental Technology

DEPARTMENT: Division of Engineering Technologies/Mathematics

DEGREE: Associate in Applied Science
Diploma in Environmental Control Operator
Certificate in Environmental Control Operator

CONTACT: Gary T. Laing
Chairman, Division of Engineering Technologies/Mathematics
Wytheville Community College
Wytheville, Virginia 24382
(703) 228-5541

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The environmental technology program at Wytheville Community College offers students three curriculums of study and the opportunity to earn an A.A.S. degree, a diploma, or a certificate. Designed primarily as a water pollution control program, courses are also available in air, noise, and solid waste.

In 1968 the A.A.S. program was initiated, followed in 1972 with the diploma and certificate. The program was revised in 1977 and new courses added. The certificate program is given in two formats, the regular college quarter system and a modular format that is operated in cooperation with the Virginia State Water Control Board.

The three curriculums are each designed to be terminal programs, however they are also designed so that credits earned in one curriculum can be applied to another. A student can, for example, begin in the certificate program and then advance into the diploma or A.A.S. programs. The Associate degree program also prepares students for transfer to a four-year Bachelor's program in another college or university. The programs prepare students for employment inseveral technical careers such as environmental planner, sanitary technician/aide, water or wastewater treatment plant operator/supervisor, laboratory technician, and public health technician/aide.

PROGRAM REQUIREMENTS

Generally, admission requirements include a high school diploma or equivalent or any person at least eighteen years of age who can benefit from this training. Additional requirements for the

A.A.S. degree include a proficiency in high school English and math. Both the A.A.S. and diploma programs are six quarters in length with 93 and 97 credits for diploma and A.A.S. degree respectively. Each program consists of about one-third of the course work in general education subjects and the remainder in environmental and technical support courses. The differences between the two programs are generally in the level of the math and chemistry courses required, i.e. the A.A.S. program requires Chemistry III - College Chemistry and Math 121 - Engineering Technical Math, while the diploma program requires Chemistry 101 - General Chemistry and Math 021 Sruvey of Technical Math. The A.A.S. program also requires three quarters of physics and one course in hydraulics which are not required for the diploma.

The certificate program is four quarters in length and requires a minimum of fifty-six credits for completion. As with the other two programs, approximately one-third of the course work is in general education subjects and the remainder in environmental or technical support courses. Students can choose to take the program in the regular four-quarter college format or through a series of concentrated modules which allow working students to complete the program without long-term absence. This format was developed by the Virginia State Water Control Board in cooperation with the state's community college system and is offered in fifteen community colleges throughout the state.

CURRENT FACULTY, STUDENTS, GRADUATES

Program faculty consists of three persons, two full-time and one part-time for a full-time equivalent of 2.2. All faculty time is devoted to teaching.

Currently, the A.A.S. program has an enrollment of thirteen full-time students and no part-time students. The certificate program has six part-time students and an additional eleven full-time students enrolled in a satellite program operated by the college at the Bland Correctional Center. This program trains inmates for water/wastewater treatment plant operator certification both for the operation of the correctional center's treatment plants and for careers following their release.

Virtually all environmental technology students are Virginia residents and are recruited primarily through distribution of flyers and brochures and by personal visits to high schools, industry, and local governments.

The A.A.S. program graduates about six students per year with slight fluctuation. An average of thirteen certificates are awarded each year and no more than one diploma is given per year. It is estimated that about twenty-five percent of the A.A.S. graduates go on to four-year degree programs while approximately five to ten percent of the graduates of the certificate program go into the A.A.S. program. Students generally have no trouble finding employment, usually through individual contacts with employers. Officials indicated that about seventy-five percent go to work in state and local government and the remainder go into the private sector.

PROGRAM PROJECTIONS

The program is expected to remain stable or increase slightly in enrollment.

ADDITIONAL INFORMATION

Program faculty members regularly conduct workshops and short courses. Annual seminars are presented for State Health Department sanitarians, lab analysis and certification refresher courses are conducted for active operators, and soil erosion and sedimentation courses put on for engineers and planners in both the public and private sectors.

COURSE DESCRIPTION

(the following is a partial listing of courses)

ENVR 124-125 Water Purification - Principles of water purification including: secretion sedimentation, rapid sand filtration, chlorination, treatment chemicals, taste and odor control, bacteriological control, mineral control, design criteria, maintenance programs, and operation forms and records. (2 q.h.)

ENVR 136 Environmental Survey - The relationship of man to his physical environment; ecological principles; public health; topics of current importance including air pollution, potable water, waste disposal, communicable disease, poisoning and toxicity, radiation, with particular emphasis on community action programs. (3 q.h.)

ENVR 211, 212, 213 Sanitary Biology and Chemistry - Theory and laboratory technique for all control tests of water purifications, including many topics such as bacteriology, color, turbidity, pH, hardness, coagulations, and others. (3 q.h.)

ENVR 216 Water Supply and Wastewater Collection - The engineering aspect of water supply, water distribution, waste water collections and waste water removal and disposal. (3 q.h.)

ENVR 217 Liquid Waste Treatment - The engineering aspects of design operation, process control, and maintenance of wastewater treatment plants and facilities. (3 q.h.)

ENVR 218 Industrial Waste Treatment - Principles and methods of contemporary industrial waste treatment; relationships between the characteristics of industrial wastes and their effects on receiving waters; differences and similarities between industrial and sanitary waste treatment. (3 q.h.)

ENVR 268 Advanced Wastewater Treatment - Study of advanced chemical and physical processes for removal of impurities from wastewater. Includes improvement of secondary treatment or installation of tertiary treatment, flow-sheet development, and engineering economy. (3 q.h.)

HLTH 111,112,113 Public Health I,II,III - Public Health administration, environmental sanitation and control both urban and rural, food and milk sanitation, radiological health, sanitary limnology, control of communicable diseases. (2 q.h.)

HLTH 241 Occupational Health I - Air Pollution and Noise Abatement - Air pollution control and noise abatement in relation to occupational health; study of the scientific, engineering, and legal aspects; sources and classification of pollutants; sampling and measuring techniques; remedies and controls currently available. (3 q.h.)

SECTION II - ASSOCIATE & BACHELORS DEGREE PROGRAMS

- Missouri Southern State College
- Oregon Institute of Technology
- Temple University

INSTITUTION: MISSOURI SOUTHERN STATE COLLEGE

PROGRAM: Environmental Health Technology (Water and Wastewater Management Option) (EHT)
DEPARTMENT: Division of Technology
DEGREE: Associate of Science in Environmental Health Technology (A.S.)
Bachelor of Science in Environmental Health Technology (B.S.)

CONTACT: Mr. James K. Maupin, Dean
Division of Technology
Missouri Southern State College
Newman and Duquesne Roads
Joplin, Missouri 64801
(417) 624-8100, Ext. 272

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Through the cooperative efforts of two nationally accredited educational institutions, Missouri Southern State College (MSSC) and the Water and Wastewater Technical School (WTTS--see elsewhere in this volume), students may earn Associate of Science and Bachelor of Science degrees in Environmental Health Technology. Missouri Southern is a comprehensive, four-year community state college. Credits from the nearby Water and Wastewater Technical School's forty-eight week course incorporating laboratory, classroom, and on-the-job training transfer as a block of thirty hours for both the A.S. and B.S. degrees.

The Water and Wastewater Management Option under the Environmental Health Technology Program is designed to provide the student with practical skills plus the academic preparation concommitant with an A.S. or B.S. degree. Research contracts provide faculty and students with necessary field experiences. Missouri Southern has been contracted for area aquatic analysis and sampling work under the legislative mandate of Public Law 92-500 which establishes regional wastewater control systems. A second contract is currently pending between MSSC and the Army Corps of Engineers to assess the environmental impact on all aquatic and terrestrial animals affected by the construction of a proposed dam in the Tulsa District. The faculty also offer a night seminar on energy for upper-division students.

PROGRAM REQUIREMENTS

The Associate of Science degree under the Water and Wastewater Management Option involves one year of coursework at WWTS and completion of an additional thirty-nine semester hours at MSSC. A student selecting the B.S. degree under the same option takes three academic years of study (102 semester hours) at MSSC preceded or followed by successful completion of the forty-eight week training course at WWTS. Admission to either degree program requires a high school diploma or its equivalent.

CURRENT FACULTY, STUDENTS, GRADUATES

Two faculty members (FTE=approx. 1.5) serve the twenty-three students (17 B.S., 6 A.S. candidates) currently enrolled in the Environmental Health Technology program. Although the enrollment has remained relatively constant over the past four years, the number graduating annually is somewhat lower than might be expected due to employment prior to completion of the degree. In 1975-76, one A.S. diploma and six B.S. diplomas were awarded. The program does attract career-change students and nurses and science teachers seeking additional training and certification. Approximately 50 percent of the EHT students continue schooling beyond the A.S. degree, particularly in Business Management and, of course, in Environmental Health; roughly 15 percent seek schooling beyond the B.S. degree.

Job opportunities with governmental and private agencies involving water supply or wastewater treatment and other environmental protection problems are excellent and constantly improving. Almost 90 percent of the EHT graduates are employed in their field of training (environmental sciences, chemistry); an estimated 30 percent go into the private sector; 30 percent to regulatory agencies; and 40 percent to municipalities.

Students seeking financial aid may apply for several programs. In addition to some CETA grants (very limited), there are Basic Educational Opportunity Grants, guaranteed student loans, supplementary education grants, and college work-study.

PROGRAM PROJECTIONS

Faculty in the Environmental Health Technology program at MSSC foresee an expanding job market, especially in the enforcement area, for their graudates. A full-time faculty member, or two part-time instructors to be shared with biology and other departments, should be added to meet rising enrollment demands; but money for that line or lines remains to be allocated.

Beginning with the summer term 1978, a new option in Institutional and Community Health will be available for students in Environmental Health Technology. The second option, developed to allow an alternative to the training offered at WWTS, combines the same three academic years of MSSC study as specified under the Water and Wastewater Management Option with a semester of coursework in genetics, entomology, parasitology, and earth environment and a 12-hour practicum at a health facility or facilities (hospitals, public health offices, small industrial labs).

COURSE DESCRIPTION

0420-312 Environmental Biology - A study of environmental factors and their interactions with living things. Emphasis is placed on human ecology and wise natural resource utilization. (4 s.h.)

0408-370 Environmental Health - A course concerned with contemporary environmental health problems and public protection measures. These will include public health disease prevention, vector control, etc. (4 s.h.)

1299-450 Practicum in Environmental Health - A course designed to allow students to gain experience through actual observation and work at health facilities, health regulation agencies, and/or industrial plants where environmental health is a viable concern. (12 s.h.)

1914-300 Earth Environments - A course describing aspects of the solid earth, the liquid environments of earth, and our atmosphere. Interactions of these and their relationships to human society will also be discussed. (4 s.h.)

See Course Description for Water and Wastewater Technical School also.

INSTITUTION: OREGON INSTITUTE OF TECHNOLOGY

PROGRAM: Environmental Health Technology

DEPARTMENT: Allied Health and Engineering Technologies

DEGREE: Associate of Applied Science (A.A.S.), Bachelor of Technology (B.T.) in Environmental Technology

CONTACT: Mr. Leroy H. Fisk
Environmental Health Technology
Oregon Institute of Technology
Klamath Falls, Oregon 97601
(503) 882-6321

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental technology programs at the Oregon Institute of Technology are conducted at two levels. The associate level program consists of an environmental health technology curriculum which includes three areas of concentration: environmental sanitation; wastewater laboratory technology; and, water quality control technology. This program of preparation for technicians, was developed in response to the needs of government and industry personnel, and leads to an Associate of Applied Science degree. It was instituted in 1967.

The baccalaureate level environmental technology program is an upper division curriculum directed at the multidisciplinary aspects of pollution control in business, industry and government. The program, established in 1974, prepares the technologist for a variety of occupational opportunities, and leads to the Bachelor of Technology degree.

PROGRAM REQUIREMENTS

Graduation from an accredited high school with a cumulative grade point average of 2.0 is the basic requirement for admission to the program at the associate level. Completion of the associate degree ordinarily qualifys the student for admission to the baccalaureate program.

Requirements for the applied sicence degree include completion on the following three quarters of course work in the first year: 16 quarter hours of English, health education and electives; eight quarter hours of mathematics; and, 27 quarter hours of chemistry and biology. The second year's requirements include: 40 quarter hours of science and mathematics; and, 13 quarter hours of technical report writing and electives.

The environmental technology program leading to the Bachelor of Technology degree includes the successful completion of a two-year, upper division curriculum. The requirements for the first year include: 22 quarter hours of subjects such as accounting, mathematics, economics and social science; 21 quarter hours of subjects such as environmental law, impact statement and analysis, psychology, and solid waste management; and nine quarter hours of technical and general electives. In the first year, the student completes 52 quarter hours of course work.

Second year requirements include: 14 quarter hours of technical electives; and, 36 quarter hours of subjects such as social science, senior project, air quality and engineering and science electives. The student is required to complete 50 quarter hours during the second year.

CURRENT FACULTY, STUDENTS, GRADUATES

The current faculty for both program sequences consists of nine full-time teaching personnel. Of the nine total personnel, three are cost-centered.

There are 77 full-time students enrolled, at present, in both programs. At the associate level, there are 50 full-time students of which 70% are male and 30% are female, approximately. The baccalaureate program consists of 27 full-time students, including 19 males and eight females.

Graduates of these programs average approximately 21 annually. Those students earning the Associate of Applied Science degree number approximately 14 per annum. The students earning the Bachelor of Technology degree average approximately seven per year. At both levels, students gain employment in the private sector predominatly (95%), while the remainder (5%) enter public sector employment. Approximately 2% of the baccalaureate students select advanced academic training over the career path.

PROGRAM PROJECTIONS

Faculty and administrators of environmental technology at Oregon Institute of Technology, anticipate significant growth at all levels in both programs. In response to the needs of industry and government, the student population is anticipated to increase somewhat. To meet these expansion plans, two additional faculty members, holding the Master of Science degree, are anticipated to join the Institute within the next two years.

COURSE DESCRIPTION

Env 310 Industrial Hygiene - Industrial environmental problems involving air, water, solid wastes, pesticides, noise, vibration, and radiation. Emphasis is placed on sources of pollutants, measures of quality effects or hazards and safety of contaminants, and controls or abatement of pollutants in the eco-system. (3 q.h.)

Env 327 Impact Statement and Assessment - Environmental impact evaluation. The study of environmental impact statements and guidelines: national environmental policy act, variables, responsible agencies, political and legal factors. (3 q.h.)

Env 412 Senior Project-Field Measurement - A problem-oriented project in field measurement; sampling and analysis of pollutants. (4 q.h.)

Env 422 Senior Project-Monitoring and Control - A problem-oriented project in pollutant monitoring and the techniques of control as they relate to air, water, solid waste disposal and the industrial environment. (4 q.h.)

Env 432 Senior Project-Industrial Pollution Abatement - A problem-oriented project in the design and implementation of pollution abatement systems and methods to a field problem. (4 q.h.)

INSTITUTION: TEMPLE UNIVERSITY

PROGRAM: Environmental Technology (A.T.)
Environmental Engineering Technology (B.S.)

DEPARTMENT: Civil and Environmental Engineering Technology

DEGREE: Associate in Technology (A.T.)
Bachelor of Science (B.S.)

CONTACT: Dr. Frederick B. Higgins
Chairman of the Department of Civil and
Environmental Engineering Technology
Temple University
Philadelphia, Pennsylvania 19122
(215) 787-7816

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The College of Engineering Technology offers two degree programs relating to environmental pollution control; Environmental Technology and Environmental Engineering Technology. The Environmental Technology Associate degree curriculum is oriented toward the training of engineering technicians to perform environmental measurement and control tasks for either industry or governmental agencies. This program is accredited by the engineer's Council for Professional Development and graduates are trained for positions as air pollution technicians, laboratory technicians, service technicians, technical representatives, and water quality technicians.

The Environmental Engineering baccalaureate curriculum is based on chemistry, biology, civil engineering, and chemical engineering aspects which would be most appropriate to study environmental quality deterioration and to the design of equipment or systems for pollution abatement and control. Students prepare for the practical application of control technology to pollution control and abatement. Students may select electives to emphasize engineering, social or management aspects. Graduates may obtain positions as project engineers with consulting companies in environmental control groups in industry, or in regulatory agencies.

The two programs utilize a wet chemistry laboratory for the analysis of environmental pollutants and an instrumentation laboratory which contains automated air and water pollution monitors. In addition, a bacteriological laboratory is available for students to use. Several pilot treatment plants are also available.

PROGRAM REQUIREMENTS

In order to be eligible for admission at Temple University sixteen units (one unit-one year) of acceptable high school work are required of which ten must include four units of English, two units of college preparatory mathematics, one unit of history, one unit of laboratory science and two units of a foreign language. College of Engineering Technology students are not required to satisfy the foreign language requirement but must instead present two additional units of mathematics and laboratory sciences.

The two-year Environmental Technology curriculum includes 66 semester hours of required courses plus an environmental field operations course (4 semester hours) during the summer between the second and third semesters. The four year Environmental Engineering Technology curriculum includes 124 credit hours of required courses over an eight semester period plus the summer field operations course.

The students participating in these programs can elect a cooperative educational arrangement as an option. Approximately three students participate each semester and the U.S. Environmental Protection Agency office in Philadelphia is the largest employer of Temple University's environmental students.

Although there are no specific departmental grants available to students as financial assistance, Pennsylvania has grants available entitled Pennsylvania Higher Education Agency and Basic Educational Opportunity Grants available. Basic Educational Opportunity Grants and other forms of federal grants are available.

CURRENT FACULTY, STUDENTS, GRADUATES

Only two faculty professors are engaged in teaching Temple University's environmental courses offered in the two degree programs. However, other full time faculty in other departments also teach major courses in noise control, solar energy, environmental impact assessment and energy and environment.

There are currently 64 full time students (nine females) and twelve part time students enrolled in the baccalaureate program. Eight students (3 females) are enrolled in the associate program. Approximately fifteen baccalaureate students and one to two associate degree students graduate annually. The baccalaureate program has been increasing steadily but not as rapidly as has been expected by program officials. Enrollment in the associate degree program has been low and appears to be declining.

Almost all of the associate degree students transfer into the baccalaureate program. However, only ten to fifteen percent of the Environmental Engineering Technology graduates continue for advanced degrees. Because of a state and city policy of hiring engineers and not technicians, few Temple graduates work for city or state environmental agencies. The U.S. EPA Regional Office in Philadelphia is a consistent employer of Temple graduates (2 each year). Recent graduates have also found employment with local water treatment equipment manufacturers and sales engineering firms (as technical representatives). Because the unavailability of public agency jobs in the Philadelphia area exists, eight percent find private sector employment.

PROGRAM PROJECTIONS

Temple University plans to offer its first baccalaureate engineering degree program in the fall of 1978. Many of the environmental courses will be corporated in the engineering curriculum. One day-adjunct instructor and six to seven evening adjuncts are expected to be recruited in the near future to teach energy and environment, air pollution, environmental impact preparation, and computer modelling courses. All will have engineering backgrounds and will teach specific courses on an adjunct basis. The Environmental Technology programs are acquiring a unit operations laboratory in a new building during 1978 and air/industrial hygiene will be taught in its facilities. The laboratory will be equipped with pilot scale water and wastewater treatment plants with capacities of between one-half to one million parts per million capacity.

As baccalaureate enrollment appears to be increasing steadily, a B.S. in Engineering Science with no departmental sponsor will be initiated. Ultimately an environmental engineering major will be developed, but no departmental degrees will be offered.

COURSE DESCRIPTION

10 Introduction to Environment- Evaluation of environmental conditions.

11 Energy & Environment- The effects of energy development and use on environmental quality.

13 Environmental Chemistry- Basic principles of chemistry and stoichiometry as they relate to environmental pollution measurements and chemical treatment.

17 Sanitary Chemistry & Microbiology- Wet analysis of environmental importance; sampling; data handling; standard test; microbiology.

24 Environmental Instrumentation-Optical, electrochemical and instrumental methods of analysis; environment applications.

31 Pollution Control Processes-Liquid and gas properties of importance in environmental control operations; sedimation, filtration, membrane processes, adsorption, ion exchange, chemical treatment.

33 Environmental Field Operations- Field aspects of environmental engineering: Air and water sampling, stack sampling, bioassay and environmental aspects of planning.

110 Air Pollution Control Systems- Principles of design and operation the major categories of air pollution control equipment.

111 Wastewater Treatment Systems- Principles of design and operation of municipal and industrial wastewater treatment plants.

113 Solid Waste Management -Refuse collection and disposal: incineration; landfill; composting; recycling; special wastes.

115 Water Treatment -Chemical and physical methods of treatment of water supplies.

116 Environmental Regulations- View of environmental regulations at the federal, state and local levels.

120 Environmental Systems Design -The practical design of pollution control systems in the areas of air, water, solid waste, industrial hygiene and noise.

210 Environmental Planning -Planning as a factor in minimization of environmental impact and on preparation of environmental impact statements.

211 Energy Resource Development -Current energy sources, available resources and methods of development.

390 Independent Study in Envt. -Student permitted to study a regular course on his own during the semesters the course is not offered, enabling student to meet prerequisite or graduation requirements.

398 Independent Research -Student will be assigned a research project with the approval of the department chairman and conducted under the supervision of a faculty sponsor.

SECTION III - BACHELORS & MASTERS DEGREE PROGRAMS

- Brigham Young University
- California State University, Sacramento
- Clarkson College
- Illinois Institute of Technology
- Marquette University
- Michigan Technological University
- The Pennsylvania State University
- Tufts University

INSTITUTION: BRIGHAM YOUNG UNIVERSITY

PROGRAM: Water Resources and Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science (B.S.) and Master of Science (M.S.) in Civil Engineering

CONTACT: Dr. La Vere B. Merritt
Associate Professor
Civil Engineering
Brigham Young University
Provo, Utah 84602
(801) 374-1211 x 2811

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Water resources and environmental engineering are two of six areas of concentration offered by the Department of Civil Engineering. Emphasis is placed on applied engineering design. A strong science and mathematics foundation is required and students begin these courses along with fundamental civil engineering problems, in the freshman and sophomore years. Accomplishment of the baccalaureate degree is possible within a special three-year program for the Bachelor of Science degree.

Graduates of this program at both levels gain employment in the following occupations: environmental engineer, water resources/ water pollution control; sanitary engineer; water resources engineer; and public health engineer. Those students who have earned the advanced degree are in a position to demand the higher salaries.

PROGRAM REQUIREMENTS

Admission to BYU is predicated upon academic achievement as demonstrated by the students secondary educational experiences and results of the American College Test. In addition, students are accepted with the proviso that they maintain the ideals and standards inherent in the philosophy of The Church of Jesus Christ of Latter Day Saints (LDS). The prospective graduate student must take the Graduate Record Examination (verbal, aptitude, and advanced engineering).

Requirements for completion of the Bachelor of Science Degree include: the general education requirements of the university; the general civil engineering curriculum for the first three years; and, nine hours of technical electives which are selected during the fourth year. During the fourth year the student may begin the course of study for the Master of Science degree.

The Master of Science degree requires a minimum of 25 semester hours plus thesis.

There is no internship program or applied study term at present. BYU places a strong emphasis on cooperative education programs, however, and thus encourages on-the-job working experience. Pursuant to this philosophy, approximately 30% of the students find employement related to their academic program. This activity usually is undertaken for one semester.

Student financial support may be augmented by means of several long and short-term loans. In addition there are several scholarship programs for both undergraduate and graduate students.

CURRENT FACULTY, STUDENTS, GRADUATES

The current faculty for both the Bachelor of Science and the Master of Science includes four teaching and research personnel. All faculty are cost-centered.

Civil engineering students presently total 50. There are 15 baccalaureate students and 23 graduate students. A dramatic decrease in the student population occured in 1973. Until that time, the water resources and environmental engineering program at BYU had attracted large numbers of Indian students. In 1973, however, there was a shift in the policies of the Indian government regarding the number of students allowed to study in the United States.

Approximately 15 students per year are graduated from the baccalaureate program. In addition, there are an average of three to four students annually who are awarded the Master of Science degree.

At present there are no formal follow-up activities regarding the program graduates. Alumnae surveys are the only means of tracing the activities of graduates.

Although students, earning B.S. and M.S. degrees through the water resources and environmental engineering program are successful at securing employment, approximately 50% of the baccalaureate graduates pursue advanced degrees. Those students choosing a career path are recruited directly by industry. The department does not maintain a placement service.

PROGRAM PROJECTIONS

The civil engineering staff is looking forward to an expansion of the degree programs over the next two to three years. In response to anticipated program growth, an increase of one faculty member is anticipated in 1979.

COURSE DESCRIPTION (Selected)

Undergraduate courses:

CE 100A, B Introduction to Civil Engineering 1 - Fields and profession of civil engineering: principles involved in solving engineering problems. (1/2 s.h.)

CE 305 Properties of Materials - Physical testing of materials, introduction to failure theories and solid-state concept of behavior of materials, and the mechanics of deformation. (3 s.h.)

CE 310 Introduction to Civil-Engineering Design - Problem definition and typical procedures in engineering analysis and design. Applying digital computer to civil-engineering problems. (2 s.h.)

CE 321 Elementary Structural Theory - Loads on structures, beams, trusses, influence diagrams, three-dimensional analysis, cable systems, approximate analysis of frames, and deflections. (3 s.h.)

CE 332 Hydraulics and Fluid Flow Theory - Fluid properties, fluid statics and dynamics, viscous flow, and boundary layer concepts. Applying theory to pipe and open-channel flow. (3 s.h.)

CE 341 Elementary Soil Mechanics - Physicochemical characteristics of soils. Permeability, seepage and associate uplift pressures. Consolidation and strength theory, shearing strengths of sand and clay, earth pressure theories, slope stability analysis. (3 s.h.)

CE 391A, B Civil Engineering Seminar - Group discussion of technical and professional activities. Participation by faculty, professional engineers, advanced students, and other invited personnel. (1/2 s.h.)

CE 431 Hydrology - Water in nature; relationships between precipitation, evaporation, infiltration, transpiration, groundwater, and stream runoff. (3 s.h.)

CE 432 Hydraulic Engineering - Applying principles of fluid mechanics to design of hydraulic structures.

CE 471 Professional, Economic, and Legal Problems in Engineering - Professional, legal, and economic problems: contracts, specifications, accounting, feasibility studies, ethics. (3 s.h.)

Graduate courses:

CE 501 Advanced Mechanics of Materials - Introduction to strain energy methods, stresses and strains in beams and curved members, beams on elastic foundations, thick cylinders, torsion, and structural members. (3 s.h.)

CE 502 Advanced Properties of Materials - Mechanics of deformation and fracture of solids; mechanical behavior or materials correlated with atomic scale mechanisms; creep, residual stresses, and fatigue. (3 s.h.)

CE 503 Applied Elasticity - Analysis of stress and strain, equations of euilibrium and compatability, generalized Hooke's Law, and energy theorems. (3 s.h.)

CE 531 Water Resources Engineering - Planning and design of hydroelectric, flood control, irrigation, drainage, and multipurpose projects involving the use of water resources. (3 s.h.)

CE 542 Foundation Engineering - Subsurface exploration, bearing capacity concepts, settlement of structures, and basic principles of foundation design. (3 s.h.)

CE 550 Water Quality Management - Philosophies, objectives, and methods of water quality management; impact of various uses on water quality; behavior of pollutants in receiving waters. (3 s.h.)

CE 551 Sanitary Engineering - Applying public health engineering to design, concstruction, and operation of water supply and sewage systems. (3 s.h.)

CE 555 Sanitary Engineering Analysis - Techniques for chemical and biological analysis of the major organic and inorganic constituents of water, sewage, and industrial wastes. (3 s.h.)

CE 641 Advanced Soil Mechanics - Topics include stress distribution in earth masses, shearing strength of soils, consolidation theory, settlement analysis, stability of slopes, and bearing capactiy of soils. (3 s.h.)

CE 643 Earth- and Rock-Fill Structures - Design and construction of earth- and rock-fill dams, selecting dam-sites and materials, seepage and pore pressure studies, shearing strength data, stability analysis, construction controls. (3 s.h.)

CE 644 Advanced Foundation Engineering - Dewatering excavations, embankments on soft clay and natural slopes, pile and caisson foundations, shallow foundation, seismic and vibrant motions, foundations on collapsible and expansive soils. (3 s.h.)

CE 646 Flow of Fluids through Porous Media - Fluid flow in saturated and unsaturated anisotropic media. Darcy's Law and Navier-Stokes equations. Potential theory and conformal mapping, analog solutions. (3 s.h.)

CE 652 Design of Water Treatment Works - Water purification and treatment for culinary, municipal, and industrial uses. (3 s.h.)

CE 653 Design of Sewage Treatment Works - Analysis and design of municipal wastewater treatment facilities. (3 s.h.)

CE 654 Industrial Waste Treatment - Treatment and disposal of industrial wastes; studies of basic industries and their waste problems. (3 s.h.)

CE 663 Pavement Design - Properties and selection of pavement components including soils, stabilized soil, base, subbase, subgrade, and bituminous materials. Design of rigid and flexible pavements. (3 s.h.)

INSTITUTION: CALIFORNIA STATE UNIVERSITY, SACRAMENTO

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science (B.S.), Master of Science (M.S.) in Civil Engineering

CONTACT:
Dr. Kenneth D. Kerri
Professor of Civil Engineering
California State University, Sacramento
6000 J Street
Sacramento, California 95819
(916) 454-6142

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Civil Engineering offers undergraduate students a major in Civil Engineering with emphasis in environmental and sanitary engineering. The students acquire a broad-based background in the physical sciences, engineering and general education courses in the humanities. Specialization may be achieved through selective use of electives in the senior year. However, students desiring a more complete understanding of a specific area are encouraged to devote an additional year to their studies in order to secure a master's degree. Students may specialize in a particular area or in a combination of areas, such as environmental and sanitary, geotechnical, structural, transportation, or water resources engineering.

The graduate programs offered through the department, include the M.S. in civil engineering, and a separate program in environmental engineering which leads also to the M.S. degree in civil engineering. There is no doctoral program at present. The environmental engineering program was begun in 1967 and has been designed to accomodate students with a wide variety of backgrounds and interests. Course work may include environmental impact statements, water quality, water resources, air resources, waste management, noise, microbiology, remote sensing, economics, and the political process. In addition to course work, students in the program are encouraged to attend and participate in seminars sponsored by local professional organizations.

PROGRAM REQUIREMENTS

Undergraduate students admitted to the university are welcome to major in civil engineering. The Bachelor's degree in civil engineering requires at least 126 semester units, including a minimum of 54 approved upper division semester units in engineering and civil engineering courses, of which 12 semester units may be civil engineering electives. Students must complete: five semester units of chemistry; 15 semester units of math; 28 semester units of engineering; one semester unit in computer science; 18 semester units in civil engineering; 21 semester units of general education; and, 12 semester units of electives.

Students seeking admission to the graduate programs must hold a bachelor's degree from an accredited institution and must meet the minimum university entrance requirements. Students are admitted to the graduate programs with a variety of educational and professional backgrounds.

Basic requirements for all master's degrees in engineering include six semester units of mathematics and/or statistics (engineering statistics and operations research), and six semester units in a departmental core area (systems analysis and treatment processes). A maximum of six semester units in a supporting field is allowed and encouraged. A minimum of 30 semester units (10 three unit courses including thesis) are required for graduates. A student may select a thesis (Plan I), or a project and a comprehensive examination (Plan II).

CURRENT FACULTY, STUDENTS, GRADUATES

At present, there are 16 full-time faculty members in the Civil Engineering Department. Of these 16, seven are involved in the environmental engineering program. There are no research faculty although some members are involved in individual projects.

In the Department of Civil Engineering there are 250 undergraduate students. The number of undergraduates emphasizing environmental concerns is not available. The graduate program enrollment includes seven full-time students, and 40 to 50 part-time students. Limited student financial support is available due to the lack of research grants. Assistance is available, however, from the university in the form of part-time teaching positions or graduate assistantships.

The program has been relatively stable in recent years. The average number of graduates at the baccalaureate level has been approximately 40 to 50 per year. The master's program in environmental engineering graduates between 15 and 20 students per year.

Of the students that seek employment, almost all find jobs in their field. The majority accept employment in the governmental sector, while about 40% go with private industry or consulting firms. Approximately 20% of the undergraduates continue their studies for an advanced degree. Although the master's program is designed as a terminal degree, 10% continue for Ph.D. study.

PROGRAM PROJECTIONS

At the present, there are no plans to expand the size or the scope of the environmental engineering programs. One of the main objectives of this program is to meet the demand of the profession. Should there be a change in this demand, the program will be revised accordingly.

In cooperation with the California Water Pollution Control Association, and the U.S. Environmental Protection Agency, CSUS offers a home-study, correspondence course in "Operation of Wastewater Treatment Plants" for persons working in the field or for those insterested in seeking employment in treatment plants. Depending upon the success of this program, there is a possibility that the University will develop other home study courses.

COURSE DESCRIPTION (selected)

CE 170 Sanitary Engineering - Collection and distribution of water and collection and removal of wastewater; treatment of water and wastewater and natural purification of water; physical, chemical, and biological characteristics of water and wastewater; source of air pollutants and their effects. (4 s.h.)

CE 171A Soil Mechanics - Composition and properties of soils including compaction, permeability, consolidation, and shear strength. (4 s.h.)

CE 172 Water Quality Engineering Analysis - Physical, chemical and biological characteristics, reactions and kinetics applicable to the analysis of water and wastewater treatment processes. (3 s.h.)

CE 173 Water Quality Engineering Design - Functional engineering analysis applicable to the design of water and wastewater treatment processes, collection and disposal systems, advanced wastewater treatment processes, water pollution control facilities and effluent disposal. (3 s.h.)

CE 177 Atmospheric Pollution Control - Introduction to the fundamentals of air pollution engineering. Causes, effects and control or air pollution; air pollution meteorology and air quality measurements. (3 s.h.)

CE 178 Environmental Engineering - Prediction and evaluation of impacts of various types of human activities on the environment. Preparation and presentation of environmental impact reports. (3 s.h.)

Graduate courses:

CE 250 Systems Analysis of Resources Development - Investigation of resource planning using the "systems approach." Objectives of resource development; basic economic and technologic concepts, and economic factors affecting system design. (3 s.h.)

CE 252 Environmental Quality Treatment Processes - Advanced treatment of unit operations and processes employed in environmental quality control. Fundamental principles and rational design considerations of the physical, chemical, and biological unit operations and processes applicable to the design of environmental engineering systems. (3 s.h.)

CE 253 Advanced Environmental Quality Analysis - Theory and application of instrumental methods of analysis as applied to the measurement for environmental quality control. (3 s.h.)

CE 270A Physical Hydrology - Study and analysis of processes governing the depletion and replenishment of the water resources of the earth. (3 s.h.)

CE 224 Environmental Quality Management - Application of economics to water resources planning and development and environmental quality management. Development of environmental objectives and evaluation of alternative solutions. Techniques of planning, principles of engineering economics, and mathematics of economic analysis. (3 s.h.)

CE 225 Remote Sensing of Environmental Quality - Remote sensing spectrum, interaction concepts, and signature available for many problemts associated with the environment: waste management; inventories of plants, animals, land usage, and damage from fires; and plant diseases and pollution. (3 q.h.)

CE 226 Air Quality Measurements - Methods of sampling, analysis and monitoring atmospheric contaminants for quantitative evaluation of air quality. Meteorological measurements of atmospheric properties relevant to atmospheric pollution. (3 s.h.)

CE 227 Atmospheric Aerosols - A detailed examination of the role of aerosols in air pollution. Physical properties and their measurement, sources of atmospheric aerosols. (3 s.h.)

CE 252 Advanced Topics in Nuclear Engineering - Advanced topics in nuclear engineering. (3 s.h.)

CE 255 Waste Management - Waste handling and disposal, magnitude of problem, sources, quantities, and characteristics of waste. (3 s.h.)

INSTITUTION: CLARKSON COLLEGE

PROGRAM: Civil and Environmental Engineering

DEPARTMENT: Civil and Environmental Engineering

DEGREE: Bachelor of Science (B.S.); Master of Science (M.S.)
(in Civil and Environmental Engineering)

CONTACT: Dr. Norbert L. Ackerman
Chairman, Department of Civil and Environmental Engineering
Clarkson College
Potsdam, New York 13676
(315) 268-6529

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The undergraduate curriculum at Clarkson College in Civil and Environmental Engineering is designed to provide an understanding of the fundamental principles of mathematics, mechanics, science, and humanities on which engineering is based. During the junior and senior years the program concentrates on various subjects in the field of civil and environmental engineering and through the selection of electives, proficiency can be developed in particular areas of interest. Elective concentrations include the areas of environmental engineering and water resources engineering.

The Civil and Environmental Engineering Department also offers a graduate program in Water Resources and Environmental Engineering. Bachelor of Professional Studies, Master of Engineering and Doctor of Philosophy (Engineering Science) degrees are also available to students enrolled in the department. The majority of the graduates enter professional practice in the fields of civil and environmental engineering.

PROGRAM REQUIREMENTS

Undergraduate applicants are required to complete sixteen units of secondary school, including the following ten academic units for admission to the School of Engineering: four units of English; four units of mathematics; and two units of science (one unit each of chemistry and physics). Admission to the graduate program is granted to applicants with an accredited baccalaureate degree in civil engineering and exceptional students with bachelor's degrees in other engineering disciplines will be considered.

Candidates for the baccalaureate degree must complete a minimum of 120 credit hours, complete the physical education or military science requirement, and achieve a minimum cumulative grade point average of 1.850. A minimum of thirty credit hours is required for the master's degree and at least twenty hours must be earned in residence. No foreign language requirement exists for this degree. A thesis and a non-thesis option is available. Thesis credit accepted towards the degree cannot exceed ten hours of credit. Fellowships and assistantships are available to graduate students enrolled in the department. Many New York state residents are eligible for the Tuition Assistance Program which provides $100 to $1,500 per year.

CURRENT FACULTY, STUDENTS, GRADUATES

A total of twenty-two faculty members contribute to the teaching of the department's curriculum. Twenty-one faculty are full-time. Research funding is provided from engineering foundations, private corporations, the U.S. Environmental Protection Agency, and the National Science Foundation.

There are currently (spring, 1978) an estimated total of 530 full-time students enrolled in the Department of Civil and Environmental Engineering (30 female). All students take at least one course in environmental engineering and approximately 20 to 30 percent (133 students) take two or more courses in this area. Enrollment has been consistently growing in the Department of Civil and Environmental Engineering and environmental engineering is considered to be a strong growth area. There are 25 students enrolled in the master's program, and approximately five are part-time.

At the baccalaureate level, there is an average of 120 students who annually receive the B.S. degree. Approximately eleven students annually receive the Master of Science degree. Of about twenty graduate students enrolled in the M.S. degree programs at any one time, twelve will graduate, six will drop out, and six will be enrolled as part-time students and take two to three years to complete the degree requirements.

It is estimated that 93 percent find employment that is directly related to their training, 4 percent in a related field and 3 percent find totally unrelated employment. The college's placement office is considered to have an excellent placement record. Placement statistics for 1975 and 1976 of Clarkson graduates show that over 77 percent were placed within three months of graduation. This includes 55 percent employed, 20 percent enrolled in graduate school, 2 percent engaged in military service, and 21 percent unreported. Of Civil and Environmental Engineering Department graduates, about 60 percent find private sector jobs and 40 percent find government positions.

PROGRAM PROJECTIONS

No changes in faculty staff or program structure are contemplated. No different degree programs are likely to be developed in the School of Engineering, as the college is at staffing and enrollment capacity.

COURSE DESCRIPTION (SELECTED)

Undergraduate courses:

CE 380 Environmental Engineering - An introduction to environmental engineering and environmental quality management. (3 s.h.)

CE 403 Civil Engineering Laboratory - A set of prescribed experiments is required related to the areas of mechanics, hydraulics, soils, materials and environmental engineering. (3 s.h.)

CE 479 Industrial Water Quality Management - A study of water supply and waste disposal problems of industry including technical and regulatory aspects. The nature of industrial wastes. Methodologies of industry waste surveys. (3 s.h.)

CE 484 Solid Wastes Engineering - The study of the principles of the collection, handling and disposal of municipal wastes, and disposal techniques including burial, composting, combustion, size reduction and densification. (3 s.h.)

CE 495 Special Projects in Civil and Environmental Engineering - An individual project is undertaken by the student under the guidance of a staff member. A complete report is required. (3 s.h.)

Advanced undergraduate and graduate courses:

CE 514 Groundwater and Seepage - Principles of confined and unconfined groundwater flow. Analysis by conformal mapping and graphical methods to determine the quantity of seepage, uplift pressures, and exit gradients. (3 s.h.)

CE 571 Water Resources - Consideration of physical, climatic, and economic geography; resources inventories; natural resource systems; conservation concepts; water supply and demand; economic, social and engineering objectives; water law, federal law, agencies, authorities and commissions; general principles of multiple-purpose regional planning; and other topics. (3 s.h.)

Graduate courses:

CE 671 Systems Design in Water Resources Development - Identification of design objectives in water resource development; system characteristics of a river basin; mathematical synthesis of hydrologic data; simulation and optimization; application to a multipurpose river basin system design. (3 s.h.)

CE 681 Water Renovation Processes I - The theory of the chemical-physical processes employed in water and waste treatment technology. The laboratory stresses pilot plant experimentation with emphasis on process design. (3 s.h.)

CE 686 Environmental Facilities Design - Emphasis will be on water supply, waste conveyance, and treatment facilities design. Topics to be covered will include water distribution system design, sanitary sewer system design, water treatment plant design, and waste treatment plant design. (3 s.h.)

CE 698 Graduate Thesis or Special Projects - Analytical or experimental studies under the direction of a faculty member specially designated. A grade and/or credit for this work presented in satisfaction of the requirements for a degree is given when those requirements are completed. (1-10 s.h.)

INSTITUTION: ILLINOIS INSTITUTE OF TECHNOLOGY

PROGRAM: Environmental Engineering

DEPARTMENT: Pritzker Department of Environmental Engineering

DEGREE: Bachelor of Science in Engineering Sciences (B.S.E.S.)
Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. James W. Patterson, Chairman
Pritzker Department of Environmental Engineering
Illinois Institute of Technology
3300 South Federal Street
Chicago, Illinois 60616
(312) 567-3556

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

In 1966, ITT established its Department of Environmental Engineering with a separate program and faculty. The undergraduate program began in 1972, and the graduate in 1963.

The Bachelor of Science in Engineering Science has a major concentration in environmental engineering. This program provides a foundation in the basic sciences and a wide variety of applied environmental engineering courses.

Graduate program options are Water and Wastewater Engineering, Air Resources Engineering, Environmental Chemistry, Environmental Resource Management, Environmental Systems Ecology.

PROGRAM REQUIREMENTS

Undergraduate admission requirements include:

1) English (4 units), History or Social Studies (1 unit), Elementary Algebra (1 unit), Geometry (1 unit), Advanced Algebra (1 unit), Trigonometry (½ unit), Laboratory Science (2 units)
2) SAT or ACT scores

Graduate admission requirements are:

1) B.S. in appropriate undergraduate (engineering or science) field from the Engineering Council for Professional Development
2) B average or 3.0/4.0 GPA

3) provisional admission is possible if additional evidence of improvement or ability is submitted by test scores and letters of recommendation
4) proficiency in one foreign language required for Ph.D. student
5) foreign students must take the "Test of English as a Foreign Language" (TOEFL)

Degree requirements:

B.S. - 131 credit hours
M.S. - 32 credit hours (5-8 hours required for thesis)
Ph.D. - 96 credit hours (24-32 hours of dissertation)

The three graduate core requirements are Environmental Chemistry (Env E501), General Microbiology (BI501) or Air Pollution Meteorology (Env E570), and Probability and Statistics (ISE421).

CURRENT FACULTY, STUDENTS, GRADUATES

During the past year, projects totalling $633,000 (2/3 federal and 1/3 private) were funded by the Environmental Protection Agency (EPA), Energy Resource and Development Administration (ERDA), Office of Water Research and Technology (OWRT), State of Illinois, National Oceanographic and Air Administration (NOAA), and the Federal Energy Administration at IIT.

While there is no internship program or applied study term at IIT, there is a Cooperative Education program for undergraduates that enables the good student to alternate semesters on the job and school at a business in the Chicago area.

One IIT Scholar, six teaching assistantships, and 13 research assistantships are available for student financial aid on the graduate level.

PROGRAM PROJECTIONS

The long-range goals and objectives of the department are to maintain the present academic quality and not to reduce the standards for the sake of attracting more students..

ADDITIONAL INFORMATION

A mobile environmental laboratory is used each summer for field studies by the faculty and students in air and water pollution. It is a completely self-contained unit equipped for standard air and water environmental analyses.

There are also three constant temperature rooms, pilot plant unit operations laboratory, Technicon Auto-Analyser, Virian 1740 dual column gas chromatography with linear temperature programmer, dual flame ionization detectors plus electron caputre and alkali flame phosphorus detectors, Varian AA120 Atomic Absorption Spectrophotometer.

COURSE DESCRIPTION (Selected)

Undergraduate courses:

ENV E 401 Introduction to Water Resources Engineering - Principles of hydraulics and water demand projections as used in the design of reservoirs, water distribution systems and storm and sanitary sewers; aspects of water resource management and environmental engineering economics. (3 s.h.)

ENV E 402 Fundamentals of Water and Wastewater Treatment - Principles and applications of physical, chemical, and biological processes for water and waste purification. Evaluation and development of standard and advanced processes relative to pollutant characteristics. Design of engineering treatment systems to meet water quality and effluent standards. (4 s.h.)

ENV E 403 Sanitary Engineering Design - Lectures and design problems on sanitary engineering processes; hydraulic design of pipe networks, pumps, wet wells; process design of water and wastewater treatment plants, process optimization for economics and process efficiencies. (3 s.h.)

ENV E 405 Chemistry of Environmental Systems - Chemical equilibrium, surface chemistry, chemical kinetics, photochemistry and environmental transformations in atmospheric and aquatic systems. Applications to natural systems and pollution control processes. (3 s.h.)

ENV E 410 Environmental Health Engineering - Analysis of environmental healgh problems at the community level, with emphasis on the function of environmental engineering in their control. Course content includes the study of communicable diseases and evaluation of effects of air, water, and noise pollution, solid wastes, and ionizing radiation. (3 s.h.)

ENV E 463 Introduction to Air Pollution Control - Air pollution sources and characteristics of source emissions, atmospheric reactions, effects of pollutants and techniques of emission control; legal and administrative aspects of air pollution control. (3 s.h.)

ENV E 480 Solid Waste Engineering - Quantities and characteristics of municipal refuse. Collection methods, equipment, and costs. Refuse disposal practices. Regional planning and management. (3 s.h.)

Graduate courses:

ENV E 501 Environmental Chemistry - Fundamental and advanced principles of environmental chemistry, including reaction thermodynamics, ionic and oxidation-reduction equilibria, and reaction kinetics. (3 s.h.)

ENV E 504 Advanced Techniques in Environmental Analysis - Principles and applications of advanced techniques in analytical chemistry appropriate to environmental surveillance and control. (3 s.h.)

ENV E 525 Advanced Water Resources - Water resources engineering, including hydrology, quality standards, groundwater flow and surface hydraulics. (3 s.h.)

ENV E 551 Industrial Waste Treatment - Industrial waste sources and characteristics, significance of industrial wastes as environmental pollutants; applications of standard and special treatment processes. (3 s.h.)

ENV E 555 Industrial Waste Treatment Design Criteria - Theoretical and laboratory development of industrial wastewater treatment systems design criteria. Evaluation and selection of unit treatment processes. (3 s.h.)

ENV E 561 Design of Sanitary Engineering Processes I - Design and layout of water distribution systems, sewage collection systems, pumping stations, and force mains. Design and economics of water and waste treatment plants. Factors influencing ultimate disposal. (3 s.h.)

ENV E 570 Air Pollution Meteorology - Physical processes associated with the dispersion of wind borne materials from industrial and other sources. Atmospheric motion, including turbulence and diffusion, mathematical models and environmental impact assessment. (3 s.h.)

ENV E 571 Air Pollution Instrumentation and Analysis - Theory and practice of emission sampling, standard and advanced techniques of pollutant identification and analysis. Introduction to basic instrumentation components, and assembly of components into analytical systems. Introduction to data telemetry and automatic data processing. (3 s.h.)

ENV E 572 Ambient Air Monitoring - Ambient air sampling and pollutant analysis. Methods for collection and identification of gaseous and particulate pollutants. Air monitoring survey design, instrument calibration, interpretation of atmospheric data. (3 s.h.)

ENV E 574 Stack Sampling and Analysis - Current practices of measuring pollutants emitted from stationary sources. Methods of collection and analysis of stack effluents including field sampling techniques and data evaluation. (3 s.h.)

ENV E 577 Design of Air Pollution Control Devices - Principles and modern practices employed in the design of engineering systems for the removal of pollutants. Design of control devices based on physical and chemical characteristics of polluted gas streams. (3 s.h.)

INSTITUTION: MARQUETTE UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science in Civil Engineering (B.S.)
Bachelor of Science in Engineering (B.S.E.)
Master of Science (M.S.)

CONTACT: Dr. Al Zanoni
Marquette University
1515 West Wisconsin Avenue
Milwaukee, Wisconsin 53233
(414) 224-7030

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Within the Civil Engineering department, there are two areas of undergraduate concentration that have application for this study. The traditional civil engineering with an environmental specialty is the avenue chosen by the majority of students. The environmental engineer is responsible for conceiving and designing systems for water supply, wastewater disposal, air pollution control and solid waste disposal.

The environmental engineering interdisciplinary curriculum replaces some of the Civil Engineering courses with chemistry, biology, statistics, etc.

The undergraduate program began in 1965, the graduate program in 1967, and the interdisciplinary program in 1971.

Environmental engineering is an interdisciplinary field at the graduate level. An undergraduate degree in civil engineering or chemical engineering provides the most desirable background for graduate studies in environmental engineering. An undergraduate degree in one of the other branches of engineering, chemistry, or biology may also be acceptable, providing certain course deficiences are made up.

PROGRAM REQUIREMENTS

Recommended high school courses for admission to the engineering curriculum are English, History, Mathematics, Physics, Chemistry, and other subjects. SAT or ACT scores are required. Both undergraduate degrees require 133 semester hours.

In the Master of Science program, the student, his/her faculty adviser, and the department chairman will meet to select Plan A (acceptable thesis) or Plan B (six additional hours of course work and a department-approved design problem, laboratory assignment or technical paper in lieu of a thesis). Plan A and Plan B require 30 semester hours. Civil Engineering courses 250, 253, 254, 256 and 257 are required in both of the M.S. programs.

CURRENT FACULTY, STUDENTS, GRADUATES

Eleven percent of the undergraduate engineering students in the fall of 1977 were women (129 of 1135). Civil engineering had 264 students, one-fourth of which were in environmental engineering. Of those 61 students, nine are women. Ten full-time and 26 part-time students are enrolled in the Masters program. Graduates number six Masters and 15 undergraduates yearly.

Marquette began their undergraduate co-op program in 1919 and presently one-third of the students participate. They are eligible after the completion of their sophomore year and because of alternating semesters of work and school, obtaining their degrees takes five, instead of the usual four years.

A $35,000 U.S. Environmental Protection Agency training grant supports five Masters students a year. The National Science Foundation and the City of Milwaukee have contributed $12,000 for water and wastewater research. The International Joint Commission on the Great Lakes has funded a two year project on water resources ($50,000). Marquette has also received a two year $20,000 grant for research on incinerator air pollution. Plumbing contractors have contributed funds for undergraduate tuition.

PROGRAM PROJECTIONS

The long-range goals and objectives of the program include expansion of the undergraduate environmental speciality and no change on the graduate or interdisciplinary emphasis on the undergraduate level.

ADDITIONAL INFORMATION

The Environmental laboratory is equipped to make physical, chemical, bacteriological, and microscopial analyses of domestic, municipal, and industrial wastes and water from all sources of supply. A new Engineering building is scheduled for completion in spring, 1978.

Five times a semester, one hour seminars are conducted by people in consulting firms, the University, sewerage commission, or graduate students. Topics discussed during the fall of 1977 were: "Solid Wastes Characterization Study for a Recovery Operation," "Highlights of the 1977 Philadelphia Water Pollution Control Federation Meeting," "Milwaukee Metropolitan Area User Charge

Program," "Pollution Loading from Urban Storm Water Runoff," "Wastewater Facilities Plan for the Madison Metropolitan Area." In addition, students are encouraged to attend at least one major water or wastewater conference held in or close to the Milwaukee metropolitan area.

COURSE DESCRIPTION

Undergraduate courses:

CiEn 091S, 092S, 093S, 094S - Grading for preceeding co-op work assignments is accomplished by review of Employer Evaluation Forms, Work Exit Reports and other materials as required during each term in school following a work period. (1 s.h.)

CiEn 123 Hydrology - Origin, distribution, and properties of waters of the earth. Concept of hydrologic cycle, and basic principles of meterology, precipitation, streamflow, evapotranspiration, and groundwater flow. Design of engineering projects for the control and use of water. (3 s.h.)

CiEn 126 Hydraulics - Fundamentals and applications of pipe flow including network solutions, open channel flow, and its applications. Hydraulics of sedimentation and sediment transport. Theory and applications of centrifugal pumps. Laboratory demonstrations of the principles involved. (3 s.h.)

CiEn 150 Sanitary Engineering - Design of facilities for the collection and conveyance of storm water and waste water and for the development, transmission, and distribution of either surface or groundwater supplies. Evaluation of physical, chemical, and bacteriological characteristics of water and waste waters. (3 s.h.)

Upper division courses that carry graduate credit:

CiEn 127 Water Resources Engineering - Surface waters, groundwater yields, probability concept in water resources design, water laws, reservoirs and dams, open channels and flow regulation, irrigation and drainage, flood damage mitigation, hydroelectric power, water resources economy and planning. (3 s.h.)

CiEn 152 Environmental Sanitation - Control of factors in the environment affecting public health and comfort of people. Communicable disease transmission, insect and rodent control, milk and food sanitation, air and water pollution, and refuse disposal. (3 s.h.)

CiEn 154 Water and Waste Water Analysis - Physical, chemical and bacteriological analyses of water and waste water. Modern instrumentation in laboratory analyses. Sanitary biology. Treatment processes and their evaluation through laboratory procedure. Application of chemical methods to water and waste water analysis. (3 s.h.)

CiEn 155 Industrial Waste Water Control - Pollution of water by industrial wastes, federal and state legislation, joint industrial and municipal waste treatment, user charges, industrial waste survey, neutralization and equalization of flows, specific industrial wastes and applicable physical, chemical and biological treatment processes for their treatment, water conservation and reuse. (3 s.h.)

CiEn 158 Principles of Environmental Health Engineering - Lectures, discussions, and demonstrations on determination and control of stress factors in the environment. Industrial hazards by exposure to solids, liquids, and vapors. Emphasis on energy forms such as sounds, ionizing and non-ionizing radiation, and heat. Community air pollution and control. Overview of environmental health engineering as presently practiced. (3 s.h.)

CiEn 159 Community Air Pollution - Sources, composition, meterology, chemistry, and physics of air pollution. Effects of air pollution on vegetation, materials of construction, animal and human health and the economy. Technique of air pollution surveys, analysis, evaluation, and control. (3 s.h.)

CiEn 160 Solid Wastes Engineering - Solid wastes and their sources, characteristics, composition, and means of treatment and disposal. Health and nuisance problems associated with solid wastes. Economic evaluation of collection and disposal methods. Feasibility of recycling and reuse. (3 s.h.)

CiEn 192 Sanitary Engineering Biology - Fundamental microbiology and biochemistry of water and waste water. Chemical and physical environmental factors that influence the design of sanitary engineering projects. Applied biology to unpolluted rivers and lakes. Hygiene of water, sewage, and air. (3 s.h.)

Graduate courses:

250 Environmental and Water Resources Economy and Planning - Relation between water quality and quantity and economical development. Effect of urbanization and industrialization on water resources. Special topics include: deterministic and stochastic water quantity and quality modeling, benefit cost ratio in water resources, optimization, irrigation water requirements, relation between power generation and water

250 (Cont'd) - resources planning, optimization and system analysis, legislation and laws. (3 s.h.)

251 Water Quality Management - Water and environment. Water quality criteria. Oxygen balance and self-purification. River, estuaries and reservoirs water quality modeling. Limnological aspects, waste assimilative capacity, thermal pollution, intake and outfall design, river and estuary water quality management systems. (3 s.h.)

253 Principles of Water and Waste Water Treatment - The application of physical and chemical unit operations such as screening, sedimentation, solids concentration, flotation, chemical coagulation, flocculation, sand filtration, chemical precipitation, disinfection, carbon absorption and ion exchange in the treatment of water and waste water. (3 s.h.)

254 Principles of Water and Waste Water Treatment II - Basic concepts of microbial metabolism, energetics, and microbial nutrition related to the biological treatment of waste waters and polluted waters. Application of trickling filters, activated sludge, stabilization ponds, and nitrogen removal operations in waste water treatment. Treatment of industrial waste waters. (3 s.h.)

256 Advanced Laboratory in Water and Waste Water Processes - Laboratory evaluation of physical, chemical and biological water and waste water treatment processes. Collection, analysis and interpretation of laboratory data, and the use of the data for evaluation and design of treatment processes. (3 s.h.)

257 Processing and Disposal of Residues from Liquid Treatment Operations - The chemical, physical, and biological characteristics of residues or sludges generated from water purification and waste water treatment operations. Consideration given to processing methods such as gravity thickening, flotation, aerobic and anaerobic digestion, chemical conditioning, vacuum filtration, centrifugation, and pressure filtration among others. Disposal methods such as incineration, wet oxidation, soil spreading and fertilization, lagooning, and landfilling are evaluated and compared. (3 s.h.)

258 Industrial Waste Analysis and Treatment - Sources and sampling of aqueous industrial wastes with respect to their pollutional characteristics and effects on the surrounding environment. Various unit operations and processes applicable to industrial waste treatment. Specific industries and their waste disposal problems. (3 s.h.)

259 Advanced Treatment of Waste Waters - Fundamentals of unit processes used for final treatment of waste water to be discharged to receiving bodies of water or to be utilized in a

259 (Cont'd) - water reuse program. Development of chemical coagulation, activated carbon, ion exchange, reverse osmosis and other techniques. (3 s.h.)

INSTITUTION: MICHIGAN TECHNOLOGICAL UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science in Civil Engineering (B.S.C.E.)
Bachelor of Science in Engineering (B.S.E.)
Master of Science in Civil Engineering (M.S.C.E.)

CONTACT: Dr. George K. Wadlin, Head
Department of Civil Engineering
Civil-Geology Building, Room 110
Michigan Technological University
Houghton, Michigan 49931
(906) 487-2520

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Students combine studies of chemical, biological and engineering backgrounds to understand and solve problems involving thermal pollution, emissions and air pollution, acoustics and sound abatement, water resources and quality and solid waste management. The program began in 1970. Courses are offered on a quarter system.

One of the five major areas of study in civil engineering at MTU is environmental engineering. Areas of concern are water collection, treatment and distribution, wastewater treatment, solid waste disposal, air pollution control, public health, watershed studies, reservoirs, water flow control, sediment transport, hydraulic machinery, irrigation dams and canals.

The B.S.C.E. is a well-rounded traditional civil engineering program in which the student may select approximately five technical elective courses in his/her field of study.

The B.S.E. is for those students who wish to concentrate their studies in the area of sanitary-environmental engineering. Each individual curriculum is developed by the student in consultation with the Professional Interest Group of the Civil Engineering Department. The student selects 25-30 technical elective courses to build a coherent environmental engineering program.

Major emphasis of the M.S.C.E. is water quality engineering and water resources engineering.

PROGRAM REQUIREMENTS

The Environmental Engineering Laboratories include 4,500 square feet equipped for studies of water quality and water and wastewater treatment processes. Major pieces of equipment include Treatment Process Pilot Plants, Beckman 915-A Total Organic Carbon Analyzer, Perkin Elmer 305-B Atomic Absorption Spectrophotometer, Gas Chromatograph, BOD Respirometer, soil penetrometer with loading frame. The Hydraulics-Water Resources Laboratory occupies about 6,000 square feet and is equipped for conventional hydraulic experiments and for meteorologic and hydrologic studies.

The environmental studies B.S.E. degree requires courses in the following areas:

Mathematics	26 quarter credits
Basic Science	40 quarter credits
Engineering Science	50 quarter credits
Engineering Analysis, design and system	40 quarter credits
Other courses	44 quarter credits

The M.S.C.E. requires 45 quarter credits and areas of emphasis are water resources engineering, water quality engineering, air quality engineering, or solid waste management.

The degree requirements for the 45 quarter credits are: 1) at least 18 credits must consist of 500 level courses; 2) not more than 18 credits can consist of 400 level courses; 3) 15 credits normally consist of Graduate Research (CE 500)--3-9 credits culminating in an engineering project report or 9-15 credits culminating in a thesis.

CURRENT FACULTY, STUDENTS, GRADUATES

Engineering disciplines are fully accredited by the Engineer's Council for Professional Development (ECPD). Four of 17 civil engineering faculty are directly involved in teaching the environmental courses.

Research funded has included U.S. Army Cold Regions Research and Engineering Laboratory, Corps of Engineers, National Science Foundation, Cleveland-Cliffs Iron Company, State of Michigan, Electric Power Research Institute, U.S. Department of Interior, and the Bureau of Mines. 1976-1977 funding was $584,000.

Undergraduates can participate in a co-op program during their junior and senior years. Thirty-five different companies and agencies offer opportunities for the students to receive valuable on-the-job training.

An undergraduate at MTU who has senior standing and who has a satisfactory undergraduate record may apply for permission to enroll in graduate study while completing the requirements for his bachelor's degree. Course credits earned after the application has been approved and not applied to the bachelor's degree may subsequently be applied toward an advanced degree. It is expected that a student accepted for early admission to a graduate program will complete all requirements for the bachelor's degree within 12 months.

	Enrollment	Graduates
B.S.E B.S.C.E.	135	25-35
M.S.E.S.	18	11

Types of graduate financial assistance are research assistantships (2), teaching assistantships, scholarships, cooperative arrangements with industry and hourly employment.

An alumni survey (1931-70) undertaken in 1971 showed that 11 percent of the 973 that returned usable questionnaires were involved in an environmental work area (sanitary engineering plus conservation and water supply.

PROGRAM PROJECTIONS

The faculty sees no change in the long-range goals and objectives of the program.

ADDITIONAL INFORMATION

An eight-member Industrial Advisory Committee was formed in April, 1977. Companies represented include Envirex, DuPont, Elzinga and Volkers, Inc., Lakeside Equipment, Department of State Highways and Transportation, Bechtel Associates Professional Corporation, Soil Testing Services of Wisconsin, Inc., Williams and Works. Members come from Michigan, Illinois, Delaware, and Wisconsin.

An annual summer program, "Women in Engineering," was held during 1977 for high school and transfer students. It began in 1973 and involves exposure to six fields of engineering plus applied technology and computer science through lectures and actual participation in laboratory projects. The lecturers are practicing women engineers from business, government, and industry. The only cost to the participants is transportation to and from MTU.

Participants are selected on a competitive basis. A strong background in math and science and an interest in technological studies is necessary. High school teachers and counselors are asked to recommend several female students who have the aptitude to engage in technological studies. High school science and math teachers as well as career counselors are also expected to participate in the workshops and learn more about engineering.

Three hundred forty-nine women from eleven states attended the three 1977 sessions which were each a week long. Fifty-three corporate friends and MTU sponsored the program. Instructional staff included women from Michigan Consolidated Gas Company, General Motors Corporation, Ford Motor Company, American Can Company, John Deere, Shell Companies, M. W. Kellogg Company, The Dow Chemical Company, Inland Steel Company, Black and Veatch Consulting Engineers, Upjohn Company, Sundstrand Corporation, Bechtel Corporation, Kimberly-Clark Corporation, 3-M Company, the Air Force, and MTU's School of Techology.

COURSE DESCRIPTION

Undergraduate:

CE104 Surveying I - Basic concepts and operations, quality measurements, distance and angular measurements, horizontal and vertical control, traverse computations. Use of transit, level, Geodimeter. Horizontal and vertical curves. (3 q.h.)

CE202 Civil Engineering II - An introduction to Fortran IV digital computer programming. Numerical analysis techniques. Problem-oriented computer languages. (3 q.h.)

CE351 Introduction to Environmental Engineering - A general survey of sanitary engineering covering water supply and sanitary sewerage systems, water and wastewater treatment, water quality, basic concepts of eutrophication of natural water, air pollution, solid waste disposal, and environmental health. (4 q.h.)

CE381 Soils Engineering - Study of the properties of soils and their application to the design of foundations and earth structures. (4 q.h.)

CE400 Professional Practice I - Presentation of the concepts and methods required to make decisions between engineering alternatives. (3 q.h.)

CE403 Professional Practice II - A study of the technique of preparing written and oral engineering reports. Study of types and purposes of engineering reports and lectures on engineering practice. (3 q.h.)

CE451 Water and Wastewater Treatment - Principles of physical, chemical, and biological processes employed in water and wastewater treatment. Design of selected individual units within water and wastewater treatment systems. (4 q.h.)

CE452 Examination of Water and Wastewater - Measurement of physical, chemical, and bacteriological parameters of water quality. Interpretation of these parameters with regard to the design and operation of treatment processes and to the control of the quality of natural water. (4 q.h.)

CE453 Environmental Impact and Protection - The relation of man's environment to public health and to its control from an

CE453 (Cont'd) - engineering viewpoint. Topics include the various federal and state laws and regulations pertaining to water quality, air quality, solid wastes and environmental impact. (3 q.h.)

CE454 Water Distribution and Wastewater Collection Systems - Application of basic courses in sanitary engineering and hydraulics to the analysis and design of water distribution systems, wastewater collection systems, and their appurtenances. (3 q.h.)

CE461 Hydraulic Engineering - A study of the hydraulics of flow in closed conduits and open channels including transitions and controls. Application to the hydraulic design of water supply, drainage and sewerage systems. (4 q.h.)

CE463 Hydrology - Study of relationship between rainfall and runoff as applied to water supply, water power, irrigation, soil erosion, and sanitary engineering. (3 q.h.)

CE464 Hydraulic Structures - The analysis and design of water-regulating structures including gravity dams, arch dams, earth dams, spillways, gates, stilling basins, and conduits. (3 q.h.)

ME104 Spatial Analysis - The theory of orthographic projection as related to the graphical solution of space problems. Elements of descriptive geometry involving space relationships of points, lines, planes, and surfaces. (3 q.h.)

ME431 Thermal Pollution - The course emphasis is on the application of thermodynamics, heat transfer, and fluid mechanics to the evaluation and control of thermal pollution. Laboratory experiments and field trips are included to assist in obtaining a proper perspective. (3 q.h.)

ME433 Noise Control Engineering I - Both theory and practice are emphasized in this course, which introduces the student to the analysis and measurement of sound and vibration as applied to noise control. The basic concepts of vibration and acoustic theory are developed and a variety of sound and vibration measuring equipment is used in laboratory experiments. The student works on team projects analyzing some actual noise problems. Special topics from the current literature in acoustics and noise control are presented. (4 q.h.)

ME435 Emissions and Air Pollution - The Federal Clean Air Act and the technical aspects of standards resulting from this act are studied including the technical approaches for meeting these standards. Control methods for mobile and stationary sources are studied. In addition, the theory for atmospheric dispersion from stationary stacks is developed and applied to a number of engineering problems. Measurement techniques for ambient, mobile, and stationary source emissions for hydrocarbons, carbon monoxide, ME435 (Cont'd) - nitrogen oxide, nitrogen dioxide, oxygen, particulate matter, and sulfur oxides are covered. (3 q.h.)

Graduate:

CE551 Solid Waste Management - A study of the quantity, characteristics, and handling of municipal solid wastes. Topics include current federal and state regulations, the analysis of collection operations, sanitary landfill design, and various resource recovery alternatives. (3 q.h.)

CE552 Industrial Waste Treatment - Study of the sources and control of water pollution from industrial waste. Topics include characteristics of major industrial wastes, waste reduction through water conservation and reuse, selected treatment processes, and joint treatment of municipal and industrial wastes. (3 q.h.)

CE553 Advanced Sanitary Engineering I - Advanced analysis and design of the physical, chemical, and biological processes employed in water and wastewater treatment. Emphasis is placed upon laboratory evaluations and on the scale-up of laboratory data for the design of water treatment systems. (4 q.h.)

CE554 Advanced Sanitary Engineering II - Continuation of CE553. Emphasis is placed upon laboratory evaluations and on the scale-up of laboratory data for the design of biological waste treatment systems. (4 q.h.)

CE555 Water Quality Hydrology - Examination of the effects of effluent discharges and runoff on surface and groundwater supplies. Emphasis is placed on describing and predicting the effects in quantitative terms. Methods for controlling and minimizing deleterious effects also are stressed. (3 q.h.)

CE556 Advanced Sanitary Engineering III - Continuation of CE554. Emphasis is placed upon laboratory evaluations and on the scale-up laboratory data for the design of advanced waste treatment and nutrient removal systems. (4 q.h.)

CE564 Water Resources Engineering - Advanced topics related to water resources engineering including: multiple purpose river development, economic analysis of river development, aspects of water law, and administrative aspects of water resources planning. (3 q.h.)

CE591-4 Seminar - Detailed study and group discussion of current literature and graduate research projects related to the broad field of civil and environmental engineering. Normally, several sections will be offered depending on the student's area of interest: environmental and water resources, structures, soils, construction, and transportation. At times, joint sessions will be held on subjects of general interest. (1 q.h. each)

INSTITUTION: THE PENNSYLVANIA STATE UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science (B.S.)
Master of Science (M.S.)
Master of Engineering in Environmental Engineering (M.E.E.E.)
Doctor of Philosophy in Environmental Engineering (Ph.D.)

CONTACT: Dr. Raymond E. Untraver, Head
Department of Civil Engineering
212 Sackett Building
The Pennsylvania State University
University Park, Pennsylvania 16802
(814) 865-8391

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Environmental Engineering Program at Penn State was first initiated in September, 1972. It is really an expansion of the Bachelor of Science degree in Sanitary Engineering, a program first started in 1908. At the undergraduate level, the program is designed to provide a basic foundation in engineering supplemented by specialized study in the areas of air, water and solid waste, and radiological protection. All students in the program will receive instruction in one of them by selecting an option for his or her last four terms. A general option is available for those students who wish to postpone specialization to a graduate level program. The major is an interdisciplinary one within the College of Engineering and it is administered by the Department of Civil Engineering. Continuous liaison is maintained with the College of Earth and Mineral Sciences.

The Environmental Engineering degrees at the graduate level are administered entirely by the Civil Engineering Department. The graduate program can also provide specialization in the areas of air, water, or solid waste.

Most students obtain employment with consulting engineering firms, regulatory agencies and industry.

Extensive laboratory facilities are provided for Environmental Engineering in the departments of the two colleges involved with research and instruction. The Department of Civil Engineering has laboratory facilities for instruction and research in the areas of water, wastewater and solid waste. The Department of Mechanical Engineering has laboratories in the area of air pollution control. Additional research and laboratory space is available in the Center for Air Environment

Studies. The Department of Nuclear Engineering operates the Breazeale Nuclear Reactor with laboratory facilities in the area of radiological protection. Facilities are avsilable in the College of Earth and Mineral Science laboratory in the areas of geochemistry, hydrogeology, and mineral processing.

PROGRAM REQUIREMENTS

Candidates with a baccalaureate degree in a field of engineering are eligible for the advanced degrees. The degree should be from an institution accredited by the Engineer's Council for Professional Development. In order to enter the College of Engineering as an undergraduate, three units of English, three units of mathematics (1½ units of algebra, 1 unit of plane geometry, and ½ unit of trigonometry), one unit of science, and eight other units are required during high school preparation.

For the B.S. degree in Environmental Engineering, 140-143 credits are required, depending on the option selected. Required are 67-68 baccalaureate degree requirements, 51 credits of major requirements and 22-24 credits for the option (general, 22; air, 22; radiological, 24; and water and solid waste, 23).

Requirements for the Master of Science degree in Environmental Engineering include 30 semester credits of course work (20 to be completed in residence), a thesis, and a twelve month completion period. No language proficiency is required.

The Master of Engineering degree in Environmental Engineering requires completion of 30 credits in residence with 27 credits in course work and 3 credits directed to the Engineering Report.

The Doctor of Philosophy degree in Environmental Engineering requires completion of a candidacy exam, language exam, comprehensive exam, dissertation, and final oral exam.

A five-year work study program in environmental engineering is available and includes alternating periods of study and employment. Two years of engineering experiences and money to offset educational costs are acquired by students admitted to this program.

At the graduate level, one and one half departmental graduate assistantships are available. Sponsored research projects are the funding sources for additional assistantships.

CURRENT FACULTY, STUDENTS, GRADUATES

Ten full-time faculty members make up the interdisciplinary faculty which teach the undergraduate level courses. Eight are from Civil Engineering (5 water quality; 3 water resources hydrology); one is from Mechanical Engineering (air pollution); and one is from the Nuclear Engineering Department (radiation). Six professors from the

Department of Civil Engineering make up the graduate Environmental Engineering staff. They devote about 70 percent of their time to teaching and 30 percent to research activities. Most research funding is from industry although the City of Philadelphia does provide some funding for research.

There are currently (Fall, 1977) a total of 130 (12-15 female) full-time students enrolled in the undergraduate program. Included are two to three part-time co-op students. At the graduate level, 19 students (1 female) are enrolled in advanced degree programs. An average of 23 undergraduates and eight graduates annually earn degrees from the Environmental Engineering program.

Approximately 20-25 percent of the undergraduates continue on for advanced degrees. Most master's students continue on to other educational institutions for doctorates. In previous years, most (60 percent) of the master's students were continuing on for doctorates at Penn State. Eighty percent of the program's graduates have obtained employment in their field and 70 percent have found jobs in the private sector, mostly with consulting engineering firms. Consulting engineering firms make an active recruitment effort of Penn State students. Only 30 percent of the program's graduates have found positions in government agencies.

PROGRAM PROJECTIONS

The Environmental Engineering Program is now at maximum capacity and little additional growth is projected. No change from the current emphasis is expected. During the last two to three years, the enrollment has increased greater than what was anticipated. Financial constraints prevent the hiring of any additional staff members for the program.

COURSE DESCRIPTION (SELECTED)

Biol 410 General Limnology - Organisms found in inland waters; biological factors affecting their distribution and relationship; intensive studies of our local streams. (3 s.h.)

Biol. 435 Ecology of Lakes and Streams - Physical, chemical, and biological characteristics of freshwater environments, with special emphasis on factors regulating productivity in freshwater ecosystems. (3 s.h.)

Bio 481 Aquatic Botany - Identification, collections, and relationships of higher aquatic plant groups; field study of habits. (3 s.h.)

CE 51 Engineering Hydrology - Water sources and losses in nature; effects of precipitation, evaporation, and subsurface percolation on streamflows; flood prediction, water resource management. (2 s.h.)

CE 70 Water Pollution Control -Quantity and quality of municipal and industrial water and waterwater. Unit operations and treatment processes for water pollution control. (3 s.h.)

CE 371 Water and Wastewater Transport Systems - Water storage and transmission; design of water distribution and sewerage systems; pumps and pumping systems. (2 s.h.)

CE 451 Advanced Hydrology - Recent advanced in deterministic, stochastic, and urban hydrology. (3 s.h.)

CE 471 Environmental Sanitation - Public health engineering applications related to communicable diseases, water supply, wastewater disposal, solid wastes, air pollution, food, vectors, and radiation. (3 s.h.)

CE 472 Water Pollution Control Processes - Principles and design of unit operations for water; domestic and industrial wastewater treatment; equipment selection and application. (3 s.h.)

CE 473 Water Quality Management - Water quality criteria and standards; fate and impact of pollutants in aquatic systems; technology available for wastewater renovation. (3 s.h.)

CE 476 Solid Waste Management - Solid waste collection, salvage and disposal techniques for municipalities and industries; cost analyses; legislation; management; financing; design optimization. (3 s.h.)

CE 570 Physical Chemical Treatment Processes I - The theory of physical-chemical processes used in the treatment of potable water and municipal and industrial wastewaters. (2 s.h.)

CE 571 Physical Chemical Treatment Processes II - The theory of physical-chemical processes used in the treatment of potable water and municipal and industrial wastewaters. (3 s.h.)

CE 572 Biological Treatment Processes - The theory of biological processes used in the treatment of municipal and industrial wastewaterss. (3 s.h.)

CE 574 Laboratory Analyses in Water Quality Control - Experiments illustrating current chemical and biochemical methods of water and waste treatment and analytical methods used in research and control. (3 s.h.)

CE 575 Industrial Waste Treatment - Surveys and data analysis; use of unit processes to meet regulatory agency requirements; disposal of gaseous and solid residues. (2 s.h.)

CE 577 Treatment Plant Design - Design of works for the treatment of water and wastewater for municipalities and industries. (1-6 s.h.)

CE 579 Aquatic Microbiology - Ecology and physiology of microorganisms of inland waters, estuaries, and oceans; microbiology of wastewater treatment. (3 s.h.)

CE 580 Stream and Estuarine Analysis - Quantitative assessment of advection, reaction, and dispersion processes in polluted waters; reaeration theory; eutrophic systems; analog simulation. (3 s.h.)

FS 430 Air Pollutants from Combustion Sources - Generation of pollutants in combustion chambers; reduction by combustion control; pre- and post-combustion treatment of fuels and effluents.

HPA 420 Environmental Health - Identification, evaluation and control of environmental hazards. Biological and social considerations of the interaction of human populations with their physical environment. (3-6 s.h.)

ME 58 Acoustics and Noise Control - Sources, measurement, description of environmental noise, transmission loss, noise reduction at source by absorption, isolators and mufflers, noise measurement exercises. (3 s.h.)

ME 458 Noise Control in Machinery - Nature of noise sources in machine elements and systems. Propagation and reduction of noise. (3 s.h.)

METAL 460 Pollution Control in the Mineral Process Industries - Recycle, utilization and pollution control of air, water, and solid wastes from mineral processing plants. Pollution control through process modification. (3 s.h.)

METEO 310 Introduction to Atmosphere Science - Survey of atmospheric processes and analytical methods of atmospheric science. (3 s.h.)

METEO 452 Hydrodynamics of the Atmosphere - Equations of motion; circulation and vorticity; elements of turbulence theory and perturbation theory; introduction to numerical weather prediction. (3 s.h.)

METEO 453 Atmospheric Thermodynamics - Thermodynamic properties of the atmosphere with emphasis on water vapor; applications to forecasting problems. (3 s.h.)

METEO 475 Chemistry of the Atmosphere - Chemical properties of atmospheric components and contaminants. Dispersion and removal processes in connection with cloud physics, circulation, and air pollution. (3 s.h.)

MICRB 400 Introductory Environmental Microbiology - Elementary ecological relationships of microorganisms in the biosphere; role of bacteria in water pollution and purification. (2 s.h.)

MN EC 484 Political Economy of Energy and the Environment - Energy-its nature, use, markets and environmental impacts. (3 s.h.)

MNG 400 Mining and our Environment - For nonmining students. Nontechnical treatment of mining methods, practices, and role in today's civilization; socioeconomic and environmental problems. (3 s.h.)

NUC E 428 Radioactive Waste Control - Nature, sources, and control of radioactive wastes; theory and practice of disposal processes. (3 s.h.)

INSTITUTION: TUFTS UNIVERSITY

PROGRAM: Environmental Health Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science in Civil Engineering (B.S.C.E.)
Master of Science (M.S.)

CONTACT: Dr. N. Bruce Hanes
Chairman, Civil Engineering Department
Tufts University
Medford, Massachusetts 02155
(617) 628-5000 ext. 442

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental Health Engineering is a multidisciplinary program providing students with a theoretical and practical knowledge of environmental health enigneering, based on a sound foundation in biology, chemistry, and engineering. The program is administered by the Civil Engineering Department and offers specializations in water quality management, wastewater treatment and control, and public health.

The program is flexible and allows students to choose courses to fit their needs and objectives. Courses may be taken in the departments of biology, chemical engineering, chemistry, economics, geology, political science, mathematics, physics, sociology, philosophy, and psychology, in addition to civil engineering. Integrated in the program are the various areas of environmental helath including domestic and industrial waste treatment, public health, experimental design, water quantity and quality, economics, and water treatment.

Program support is provided by the Civil Engineering laboratories which are equipped for chemical, bacteriological, and radiological work.

PROGRAM REQUIREMENTS

Admission to the B.S. program requires a high school diploma, preferably with a sound foundation in English, mathematics, a foreign language, social studies, and a laboratory science. Scores from either the Scholastic Achievement Test or the American College Test are also required.

For the M.S. program, generally an undergraduate grade point average of at least 2.5/4 is required. This may be waived under special circumstances. Also, the Graduate Record Exam is desired but not required. Applicants should have an undergraduate degree in an engineering discipline, but those with backgrounds in the natural, physical, or social sciences will also be considered.

The B.S. degree requires the completion of thirty-eight courses which must include the following:

1. Introductory courses in math, physics, engineering, science, and chemistry.
2. Nineteen courses required by the department for a concentration in environmental health engineering.
3. Six courses in the humanities and social sciences.
4. Five elective courses, to include two science electives, one engineering elective, and two free electives.

Requirements for the M.S. degree include nine courses, of which at least six must be earned in civil engineering subjects, with the remainder in allied fields. A thesis may be required, depending on the student's civil engineering courses. There are no foreign language or residence requirements and the program can normally be completed in twelve to eighteen months.

CURRENT FACULTY, STUDENTS, GRADUATES

A total of four faculty members participate full-time in the program, with about seventy-five percent of their time devoted to teaching and the remainder in research. In addition, the program draws upon other faculty for some teaching. Research funding is currently provided by the EPA and the U.S. Public Health Service.

There are presently twenty full-time and two part-time undergraduates and twenty-four full-time and two part-time graduate students. A majority of the students come to the program through the informal referral by faculty or former students. No formal recruiting is done by the program. Most of the graudate students are receiving some form of financial assistance. During the 1976-77 academic year, there were nine EPA traineeships, two Public Health Service traineeships, two research assistantships from the National Council for Air and Stream Improvement, one teaching assistantship, and three tuition scholarships.

The B.S. program had twenty graduates in 1977, a decrease from the thirty-five in 1976. An average of about twelve students receive the M.S. degree each year and this figure remains stable. It is estimated that approximately thirty-five percent of program graduates go on to further education while the remainder find employment. Of this remaining number, apporximately forty-five percent are employed by government agencies, about thirty percent work for consulting firms, fifteen percent have jobs in private industry, and about ten percent work in other positions such as teaching or research. Most graduates find positions of employment through faculty contacts or the university placement service.

PROGRAM PROJECTIONS

Program officials do not anticipate any expansion in program or faculty in the next few years.

COURSE DESCRIPTION

(the following is a partial listing of courses)

12 Hydrology and Water Resources - A quantitative study of the hydrologic cycles with emphasis on the nature and distribution of precipitation and stream-flow. Other topics include infiltration, groundwater, evaporation, flood-routing, and reservoir yield. (no specified semester hours)

32 Water Plant Design - Application of mathematics, basic science, engineering science, hydraulics, chemistry, physics, and bacteriology to the design and operation of units used for the treatment of drinking water. (no specified semester hours)

131 Advanced Hydraulics - A course designed to broaden the student's background in engineering problems involving the flow of fluids. Various current topics included. (no specified semester hours)

133 Waste Water Plant Design - Application of mathematics, basic science, engienering science: hydraulics, chemistry, physics, and bacteriology, to the design and operation of units used for the treatment of waste water. (no specified semester hours)

134 Water and Waste Water Chemistry - The application of basic fundamentals of analytical, physical, and organic chemistry to the quantitative analyses necessary for the research, design, and operation of sanitary engineering processes. (no specified semester hours)

158 Urban Environmental Health - The interrelationship between the health and well-being of urban citizens and the residential environment. Physical aspects of housing and neighborhood; capabilities and limitations of codes and regulations. (no specified semester hours)

240 Principles of Waste Water Treatment - A study of the underlying principles important in the design of aerobic biological treatment systems. (no specified semester hours)

SECTION IV - BACHELORS, MASTERS & DOCTORAL DEGREE PROGRAMS

- Carnegie-Mellon University, Carnegie Institute of Technology
- Cornell University
- Massachusetts Institute of Technology
- Ohio State University
- Renssalaer University
- State University of New York, Buffalo
- Syracuse University
- University of Missouri, Columbia
- University of Nebraska
- University of Pittsburgh
- University of Rhode Island
- Utah State University

INSTITUTION: CARNEGIE-MELLON UNIVERSITY
CARNEGIE INSTITUTE OF TECHNOLOGY

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science (B.S.), Master of Science (M.S.), Master of Engineering (M.E.), Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Francis Clay McMichael
Head, Department of Civil Engineering
Carnegie-Mellon University
Carnegie Institute of Technology
5000 Forbes Avenue
Pittsburgh, Pennsylvania 15213

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering is not emphasized as a formal program at the Carnegie Institute of Technology. Emphasis is placed on research on environmental topics which is mainly conducted by departments of the College of Engineering. The principal areas of research are air pollution, industrial wastewater, solid waste management and energy. The principal degree granting departments in the College conducting environmental research are the Chemical, Civil, Mechanical and Engineering and Public Policy Departments. The Engineering and Public Policy Department is also part of the Graduate School of Urban and Public Affairs. All of these departments are involved in undergraduate projects and graduate thesis research in the field of environmental engineering.

Selected institutes or research programs of the Carnegie Institute of Technology which are involved in environmental engineering are the Environmental Studies Institute (to be renamed the Center for Energy and Environmental Studies) which grants an M.E. in Environmental Studies, and the Division of Nuclear Science and Engineering.

The Department of Civil Engineering offers a graduate study option in Environmental Engineering. Emphasis is on water and wastewater treatment and management, and students receive a sound understanding of water science and water process technology. The Department cooperates with other departments and colleges within Carnegie-Mellon University to sponsor interdisciplinary programs leading to special degrees or joint degrees.

Research facilities for use of students in the program include an Environmental Engineering Laboratory for research mainly in the areas of water and wastewater chemistry. A unit operation laboratory is also utilized for both teaching and research. A clean laboratory is presently under construction for aerosol studies. Analytical facilities are available to measure common inorganic and organic indices of water quality.

PROGRAM REQUIREMENTS

The Department of Civil Engineering offers a variety of degrees at the Master's level. They include: M.S. in Civil Engineering; M.S. in Civil Engineering/Engineering and Public Policy; and Master of Engineering. The Master of Science degree requires a minimum of 96 academic units consisting of:

(1) at least 36 units of graduate courses in Civil Engineering,
(2) a minimum of 24 (a maximum of 42) units of graduate project,
(3) other approved courses as suggested by the faculty advisor, and;
(4) satisfactory completion of either a comprehensive final examination or an M.S. thesis.

The Department's Master of Engineering degree normally requires a minimum of 192 units of work with strong emphasis on interdisciplinary project work. Students register in an engineering department but select problems drawn from areas such as the enviornment. Ph.D. candidates complete an additional two years of graduate study beyond the M.S. degree. A qualifying examination and final examination are required, but no foreign language is required. There is a one-year residence requirement for the Ph.D.

Research assistantships, teaching assistantships and fellowships are offered to graduate students as financial aid. A much greater number of assistantships is available in comparison with the number of fellowships. Graduate assistantships are usually one-third time appointments requiring 12 hours of work for the Department weekly.

CURRENT FACULTY, STUDENTS, GRADUATES

The College of Engineering faculty, totalling about 90, teach both undergraduate and graduate students. The faculty devote about 67 percent of their time to teaching and 33 percent to research activities. The Civil Engineering faculty is composed of thirteen members, of whom six are full professors. Three professors have research interests in environmental engineering areas.

During 1977, the College of Engineering had research expenditures totalling about $6 million, of that amount, $3 million was for energy research, and one-third of the energy expenditures ($1 million) was for environmental-energy research. The main funding source is the National Science Foundation, and ten percent is provided by industry.

The College of Engineering has a total undergraduate enrollment of 1,200 students, most of which are full-time. Approximately 90 percent are male. There are about 400 graduate students (5% female) and approximately 40 are part-time. It is estimated that 350 students annually complete the baccalaureate requirements and 100 students earn advanced engineering degrees. In Civil Engineering, twenty students were enrolled in the Master's programs in the fall of 1976, and eight students were enrolled in the Ph.D. program. During the 1975-76 school year, 34 students earned undergraduate degrees, 19 earned Master's degrees and two students received the Ph.D.

Approximately twenty percent of the students receiving B.S. degrees continue directly to graduate schools. It is expected that all graduates obtain employment directly in their field and 70 percent obtain positions in the private sector. Although the university maintains a Placement Office, students are also very successful in obtaining employment through individual contacts.

PROGRAM PROJECTIONS

Emphasis in the environmental engineering program in future years will remain on industry and the attempt to solve environmental and energy, fuel substitution, solar energy, and increased coal use problems. The Civil Engineering Department has no intention of developing a separate undergraduate major in environmental engineering. No change is foreseen in the institutional arrangements for degrees, but an increased emphasis on energy/environmental problems is expected. One additional faculty member was recently added to the environmental engineering program in the Civil Engineering Department. He has a doctorate, and his research interests include air pollution, and specifically, in trace metals in aerosols.

COURSE DESCRIPTIONS

12-721 Dynamic Hydrology - A theoretical basis is provided for analyzing water movement within the hydrology cycle; survey of important principles used in the analysis of ground water flow with applications to basin-wide ground water management; the design of industrial and domestic land and deep well waste disposal systems and to the prevention of water problems in coal mining operations; and other topics.

12-722 Wastewater Treatment: Theory and Design - Theory and design of wastewater treatment unit operations including sedimentation, activated sludge, and biological filtration. Material covered includes biological process kinetics, and theory and practice of advanced wastewater treatment processes. The design of solid handling systems focuses on thickening, digestion, incineration, and terminal disposal facilities. Laboratory sessions illustrate the application of computers to design of wastewater treatment plants, and the measurement of pertinent physical and chemical properties of wastewaters.

12-723 Water Resources Chemistry - A rigorous yet practical basis for applying the principles of chemical equilibrium and kinetic models and physical chemistry to a description of the composition of waters and to water and wastewater treatment processes. Laboratory sessions illustrate chemical principles of dilute aqueous systems and provide familiarity with chemical measurements commonly used in water and wastewater engineering.

12-732 Special Topics in Environmental Engineering - Development and application of models for assessing environmental problems with an emphasis on air pollution. Both elementary and more advanced models will be discussed. Consideration will be given to causes and effects of air pollution, control technologies, energy consumption rates and costs, and the need for efficient data collection and management. The course also includes studies of modeling atmospheric transport of air pollutants from source to sink. Offered from time to time as demand warrants.

INSTITUTION: CORNELL UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Environmental Engineering

DEGREE: Bachelor of Science (B.S.)
Master of Science (M.S.)
Master of Engineering (Civil) (M.Eng.) (Civil)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Charles Gates
Department of Environmental Engineering
Cornell University
Ithaca, New York 14852
(607) 256-3658

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering is a major program of the School of Civil and Environmental Engineering and offers both undergraduate and graduate degrees. At the graduate level, a student may concentrate in one of five areas: environmental quality engineering, fluid mechanics and hydrology, public and environmental systems engineering, transportation, and water resources planning and analysis (Ph.D. only).

The current program grew out of a sanitary engineering program which began in the early twentieth century. It is now interdisciplinary in nature and several faculty members hold joint appointments within the Department of Environmental Engineering and various other departments in the university. Degree programs are flexible and allow students to pursue subjects relating to their interests.

Several support facilities are available in conjunction with the program. These include special laboratories in sanitary engineering, hydraulics and hydrology, and transportation, as well as computer terminals and computerized data resources. In addition, an interdisciplinary research center cooperates with the Department of Environmental Engineering: the Center for Environmental Research.

PROGRAM REQUIREMENTS

Admission to the B.S. program requires a high school diploma with at least sixteen units (one unit is equivalent to one year of study) of college preparatory subjects. These must include four units of math, one of physics, and one of chemistry. The remaining units are normally in English, foreign language, history, social science, and natural or life sciences. Prospective candidates are requiredto take either the Scholastic Aptitude Test with achievement tests in math and physics or chemistry or the American College Testing program.

For entry into the M.Eng. program a student must have a baccalaureate degree from an accredited engineering program or its equivalent in an appropriate area of engineering or science. Cornell gradautes must have a cumulative grade point average of 2.5/4 or petition for entry if average is lower. Graduates of other schools must provide evidence of undergraduate preparation equivalent to Cornell's, two letters of recommendation and a statement of academic purpose.

Requirements for admission to the M.S. and Ph.D. programs stipulate that applicants must hold a baccalaureate or equivalent degree from a college or university of recognized standing.

The undergraduate degree program is designed to provide a student with an introduction to civil and environmental engineering technology and the opportunity for liberal study. A minimum of one-hundred and twenty-six credits are required for the degree. The first two years are spent in a Basic Studies Program which includes the requirement that two engineering core science courses be taken in each term of the sophomore year. Mechanics of Solids is required as one of the courses and it is recommended that Introductory Engineering Probability and either Dynamics or Mechanical Properties of Materials be taken as two of the remaining core courses. Students with special interests can depart from the third and fourth year curriculum and develop their own program in consultation with a faculty advisor.

The M.Eng. program is one year in length and is designed to prepare students for careers as professional engineers. A minimum of thirty credit hours of graduate level work are required along with an engineering design project and a formal report on the project. Four specific courses are required, two in Professional Practice in Engineering, and two in Civil and Environmental Engineering Design Project. The remainder of the program is designed by the student in consultation with an academic advisor.

Both the M.S. and Ph.D. degrees require work in major and minor areas of concentration, such as the five areas mentioned previously. These degrees also require a thesis on research conducted under the direction of a faculty member. The M.S. and Ph.D. programs are designed for students seeking careers in academic or research work.

CURRENT FACULTY, STUDENTS, GRADUATES

Currently there are four faculty members assigned to the program, each of whom teaches about one-half time and conducts research about half time. Research funding for the program has come from various sources including the National Science Foundation, the Office of Water Research and Technology (Department of the Interior), the New York State Energy Office, The Ford Foundation, and EPA.

Fifteen full-time students are enrolled in the undergraduate program and eighteen full-time are in the graduate programs. It is estimated that about half of the students come from the east coast area even though no data is kept on in-state/out-of-state students. Recruitment by the program is informal and accomplished primarily through faculty contacts with other schools and advertising via announcements and brochures. Most students are receiving some form of financial assistance, especially at the graduate level. Sources include EPA training grants, teaching and research assistantships, and engineering scholarship funds. There are approximately fifteen bachelor's degrees awarded each year and an equal number of gradaute degrees. These figures are down slightly from the number of graduates in previous years. Officials estimate that about seventy-five percent of the B.S. graduates go on to graduate school while only about ten percent of Master's degree candidates continue their education. Most of the B.S. graduates, about eighty percent, find employment in private industry or consulting firms and approximately seventy-five percent of the graduate students work in the private sector. A large part of the remaining graduates find positions in the government. Generally, students are placed in positions through faculty contacts and through the university and College of Engineering placement services.

PROGRAM PROJECTIONS

It is anticipated that program levels will remain stable with no increase in students or faculty forseen.

ADDITIONAL INFORMATION

Program officials conduct a one week summer educational seminar on industrial waste engineering, primarily for industry officials. Another seminar, on solid waste management, is being planned for industry and regulatory agencies.

COURSE DESCRIPTION

(the following is a partial listing of courses)

IIE 301 Environmental Quality Engineering - Introduction to air, water, and solid waste aspects of environmental quality envineering with emphasis on water quality concepts, theory, and methodology. (3 s.h.)

IIE 602 Water-Quality Control - Biological, chemical and physical fundamentals underlying water and wastewater treatment and their application of the analysis and design of processes for the treatment of natural waters and of wastewaters. (3 s.h.)

IIE 610 Chemistry of Water and Wastewater - Principles of physical, organic, inorganic, and biochemistry applicable to the understanding, design, and control of water and wastewater treatment. (3 s.h.)

IIE 620 Environmental Quality Control - Environmental pollution problems: their nature, causes, and effects. Concepts, phenomena, and methodology fundamental to protection of the air-land-water environment. (3 s.h.)

IIE 630 Solid Waste Management - Study of municipal, industrial, and agricultural solid wastes. Emphasis on waste characteristics, methods of treatment and disposal, and interrelationships with air, water, and land environment. (3 s.h.)

IIE 631 Industrial Waste Engineering - Characterization of liquid gaseous, and solid industrial wastes; their effects on receiving media. Treatment and disposal alternatives. Legislative and regulatory aspects of industrial waste control; industrial effluent guidelines and limitations. (3 s.h.)

IIE 633 Environmental Quality - An introduction to environmental quality and pollution problems: their nature, causes and control. (3 s.h.)

IIE 634 Air Quality Control - An introduction to air quality and air pollution porblems. Sources, natures, and effects of specific air pollutants; their dispersion and interactions in the atmosphere. (3 s.h.)

IIE 791 Design Project in Sanitary Engineering - The student will elect or be assigned problems in the design of water and wastewater treatment processes or plants; wastewater disposal systems; water quality control systems; water resource development or management systems. (variable s.h.)

IIC 609 Descriptive Hydrology - Introduction to hydrology as description of the hydrologic cycle and the role of water in the natural environment. (2 s.h.)

IIC 620 Analytical Hydrology - Physical and statistical analysis related to hydrologic processes. (3 s.h.)

IIB 619 Environmental Systems Analysis - Application of systems analysis, environmental engineering, and economics to environmental quality management systems. (3 s.h.)

IIB 747 Environmental Policy Analysis - Current research topics concerning the application of economic and simulation techniques to the definition and evaluation of public policy alternatives for managing air, land, and water resources and the material and energy wastes released into the environment. (3 s.h.) (3 s.h.)

IIH 615 Water Resources Problems and Policies - A comprehensive approach to water resources planning and development. (3 s.h.)

IIH 718 Water Resources Systems - Application of economics, engineering, and mathematical optimization and simulation models to river basin planning and regional development, hydropower and irrigation planning, reservoir operation, flow augmentation for quality control, watershed runoff, and other multiobjective, multipurpose water resources planning and management problems. (3 s.h.)

INSTITUTION: MASSACHUSETTS INSTITUTE OF TECHNOLOGY

PROGRAM: Water Resources and Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science (S.B.)
Master of Science (S.M.)
Doctor of Science (Sc.D.) or Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Frank E. Perkins
Head, Department of Civil Engineering
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139
(617) 253-2214

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Water resources and environmental control is a division of the Civil Engineering Department and offers education and research opportunities in three interrelated areas of water quality: hydrodynamics and coastal engineering, hydrology and water resource systems, and water quality control and ecology analysis.

The graduate program in water resources was created with the civil engineering program at MIT and an undergraduate program added in 1971. The program is structured so that a student may follow a pattern in one of three disciplines: physical systems, systems methodology, and social and management systems

A major supporting unit of the program is Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, which contains water research laboratories as well as computer facilities.

PROGRAM REQUIREMENTS

Admission to the undergraduate program requires a high school diploma with a minimum number of units (one year of study) in specified subjects. These include four units of English, two units of Algebra, one unit each of plane geometry, physics, and chemistry, and one-half unit of trigonometry. All applicants are also required to take the Scholastic Aptitude Test and three achievement tests and to have a personal converence with a member of the MIT Educational Council.

Requirements for admission to the Master's program requires a bachelor's or equivalent from a college, university or technical school of acceptable standing and the student's record must indicate ability to accomplish an approved program of study and research. Ph.D. or Sc.D. applicants are generally required to qualify for a Master's degree before being admitted. The graduate programs do not require an undergraduate degree in civil engineering.

Two options for the S.B. degree are available to students. First is the S.B. in Civil Engineering which follows a traditional civil engineering curriculum, and the second is the S.B. (without designation), designed for students whose interest is divided between one area of civil engineering and an outside field such as environmental planning. General requirements of the degree include sixty credit hours of science, seventy-two hours of humanities, arts, and social sciences, forty-eight hours of science distribution and laboratory requirements, and a minimum of one hundred and eighty hours in the student's program of study, including electives.

The S.M. degree requires the completion of at least sixty-six units of study of which forty-two must be in the student's major field of specialization. A thesis is also required. The Sc.D. and Ph.D. degrees are offered interchangeably and completion of program requirements qualify the student for either degree he chooses to receive. Requirements include the completion of a program of advanced study approved by the department and the completion and defense of a thesis on original research.

CURRENT FACULTY, STUDENTS, GRADUATES

Program faculty consists of a total of eleven members, all of whom divide their time between teaching and research. It is estimated that about sixty percent of their time is devoted to teaching and the remaining forty percent devoted to research. Funding for research activities comes from various sources, including the National Science Foundation, EPA, the Office of Water Research and Technology (Department of Interior), the Energy Research and Development Administration, the National Oceanographic and Atmospheric Administration, and several public utilities and private foundations.

Current program enrollment consists of twenty-seven full time undergraduates, forty full-time students in the S.M. program, and twenty-five full-time in the Sc.D. or Ph.D. program. Few of the students are career change. No ratio of in-state/out-of-state students is kept, but approximately one-third of the students are foreign. Recruitment is accomplished through personal contacts by faculty members and through the distribution of brochures to other schools. Almost all students in the program receive some form of financial assistance. It is estimated that fifty percent of the graudate students have research fellowships, another fifteen percent have teaching assistantships, and the others have various fellwoships and training grants.

The average number of graduates each year includes ten undergraduates, twenty-eight in the S.M. program, and seven in the Sc.D. or Ph.D. program. The figures are expected to remian stable. Approximately tow-thirds of the S.B. graduates continue their education, while about one-third of the S.M. graduates do likewise. Officials indicated that most graduates of the Master's program found employment with consulting firms and only about twenty percent went to work for government agencies. Of the doctoral program graduates, about two-thirds go into teaching or research and the remainder work primarily for consulting firms. Placement of graduates is usually done through faculty contacts or the MIT placement office.

PROGRAM PROJECTIONS

No change in the program is anticipated for the next few years. It is possible that additional faculty will be hired, but only to fill current vacancies.

ADDITIONAL INFORMATION

Program officials conduct one to two week summer programs in water resources and environmental engineering for industry and government agencies. They have also run one to two day seminars of a similar nature.

COURSE DESCRIPTION

(the following is a partial listing of courses)

1.106 Water Resources Laboratory Projects - Students design and perform an experiment to solve a problem in water resources engineering, and analyze and evaluate the results of the experiment. (3 s.h.)

1.60 Introduction to Water Resources - The role of water as a natural resource subject to development, utilization, management and control. Topics of current interest. (3 s.h.)

1.61 Engineering and Management of Water - Overview, integration, and application of the technological subjects taken by students completing (or who have completed) their undergraduate primary programs in water resource systems and environmental engineering. (4 s.h.)

1.66 Problems in Water Resources and Hydromechanics - Advanced topics selected by students for individual study with staff approval. (no specified semester hours)

1.681 Measurement and Modeling of Physical Processes in Water Environment - The role of analytical and numerical models. laboratory experimental studies, and field surveys in research, design, and environmental impact evaluation. Emphasis on the hydrodynamics of natural water bodies. (3 s.h.)

1.72 Groundwater Hydrology - A basic subject analyzing the role of groundwater in the hydrologic system. Many relevant topics included. (3 s.h.)

1.723 Subsurface Water Quality - An examination of subsurface water quality problems, from chemical, biological, and physical view points in the context of groundwater quality management. Other topics of current interest. (3 s.h.)

1.731 Water Resources Systems - Introduction to the fundamentals of water reosurce systems analysis, involving the determination of the optimal dimensions, target out-puts, and operating policies of water resource projects. Overview of methodologies of analysis: use of optimization techniques for solving water resources problems. (3 s.h.)

Water Quality Contorl and Environmental Management

1.75 Numerical Modeling and Sampling of Pollutant Transport - Using various numerical models as case studies, strategies for environmental modeling discussed. Emphasis placed on the transport of waterborne pollutants. Many topics included. (2 s.h.)

1.77 Water Quality Control - Analysis of environmental engineering problems in water quality and pollution control technology. Emphasis on predicting the distribution and fate of effluents discharged into lakes, reservoirs, rivers, estuaries, and oceans. (3 s.h.)

1.78 Water Quality Management - Systematic approach to the management of water quality. Identification of major issues and problem areas. (3 s.h.)

1.86 Element Cycles in the Environment - Cycles of major elements such as water, xoygen, nitrogen, carbon, and phosphorous and some key trace elements such as lead and mercury. Energetic aspects of the cycles, interrelated physical, chemical and biological processes. The approach is quantitative and focuses especially on man's interaction with his environment as it affects the distribution and processing of elements through agricultural and industrial development. (3 s.h.)

INSTITUTION: OHIO STATE UNIVERSITY

PROGRAM: Civil Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science, Hydraulics Engineering-Hydrology (B.S.); Bachelor of Science, Sanitary Engineering (B.S.); Master of Science & Doctor of Philosophy, Environmental & Water Chemistry (M.S., Ph.D.); Master of Science & Doctor of Philosophy, Hydrology & Hydraulic Engineering (M.S., Ph.D.); Master of Science & Doctor of Philosophy, Sanitary & Environmental Engineering (M.S., Ph.D.); Master of Science, Civil Engineering & Public Administration (M.S.)-Public Works Administration/Environmental & Engineering Management; Doctor of Philosophy, Civil Engineering (Ph.D.)

CONTACT: Dr. Otis J. Sproul, Chairman
Department of Civil Engineering
Ohio State University
470 Hitchcock Hall
Columbus, Ohio 43210
(614) 422-2771

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The current College of Engineering Catalogue summarizes well the undergraduate Civil Engineering curriculum and its environmentally related program options. It notes:

> The future civil engineer needs to be versed in a number of disciplines in order to cope with the various problems he will encounter in the practice of his profession. In the civil engineering curriculum at The Ohio State University, the student studies fundamental methematics and science, on which much of engineering is based; social sciences and humanities, to broaden his perspective and to prepare him for professional interaction with people; a core of basic civil engineering subject areas, including courses in transportation, structures, water resources, materials, and applied mathematics; and a personally tailored group of electives in the student's selected area of concentration.

Major elective options available to students in the undergraduate Civil Engineering program include:

Sanitary Engineering--distribution and collection, design of treatment facilities
Hydraulic Engineering and Hydrology--hydraulics, hydrology, fluid mechanics, water resource systems analysis
Environmental and Engineering Surveys--surveying, photogrammetry, remote sensing

The graduate level offerings in the department are likewise varied. To obtain a Master of Science or Doctor of Philosophy degree in Civil Engineering, students must complete a minimum number of courses in an area of specialization; among these are areas of emphasis in Environmental and Water Chemistry, Hydrology and Hydraulic Engineering, and Sanitary and Environmental Engineering. A dual M.S. degree program with the Department of Public Works Administration is designed for those persons seeking administrative and technical positions with state and federal environmental protection agencies and private consulting engineering companies.

Students in these Civil Engineering programs utilize numerous facilities and laboratories on the Ohio State University campus. With the City of Columbus, the Water Resources Center is now building some pilot-plant equipment to be used in water treatability research. An Engineering Experiment station administers sponsored research and service programs throughout the College of Engineering, and in addition to the Water Resources Center, maintains a 10 K.W. Nuclear Reactor, and a Transportation Research Center. The CLEAR (Center for Lake Erie Area Research) project maintains a laboratory at Put-in-Bay on Lake Erie which is open to OSU students and staff. The Department of Civil Engineering also sponsors short courses for practitioners on such topics as design procedures, environmental impact statements, small dam design, and hydrology of lakes.

Currently faculty research projects are funded by both the Ohio and the U.S. Environmental Protection Agencies, Office of Water Research and Technology, Engineering Experiment Station, International Joint Commission, City of Columbus, Battelle Memorial Institute, the U.S. Army Corps of Engineers, and the U.S. Army Research and Development Command. Topics and/or areas of interest include: gas movements in sanitary landfills; fluid mechanics laboratory apparatus; prediction of nutrient, oxygen, plankton, and sludge distributions in a stratified euthropic lake; Lake Erie shore erosion damage; mechanism of soil erosion by runoff; predictive and pollution abatement modeling for mine drainage; mechanism of ozone inactivation of waterborne viruses, recovery of ultrafine coal particles by microflotation; integration and synthesis of watershed studies on the effects of land use on pollutant loadings to Lake Erie; assessment impacts of energy conversion on the environment of the Ohio River Basin; inactivation of cysts with cynauric acid compounds; and elimination of filamentous blue-green algae at the Southerly Sewage Treatment Plant (Columbus).

PROGRAM REQUIREMENTS

To complete the B.S. degree program in Civil Engineering, a student must obtain a minimum of 200 quarter hours of credit. In addition to a set of core courses, undergraduates must take 31 hours in Major Option and Professional Electives in the third and fourth years. Major options (e.g., sanitary engineering) include specific required courses (approximately 14 hours) and recommended courses for Professional Electives. It is possible to count the required courses in one Major Option as Professional Electives in another Major Option. In exceptional cases, a student may work with the faculty advisor to design an honors program for the entire 31 required credit hours.

A baccalaureate degree in Civil Engineering for an Engineering Council for Professional Development accredited curriculum satisfies the admission requirements for graduate study. Applicants with other baccalaureate degrees in engineering, in allied fields, or from non-accredited curricula will be considered for admission in accordance with the College of Engineering admission policy guidelines. Such students may be required to take additional courses depending upon their preparation and objectives.

To obtain an M.S. degree in Civil Engineering, students must complete a minimum total of 45 graduate credit hours of coursework and 9 graduate credit hours of thesis. (A non-thesis, 50 graduate-credit hour plan is permitted only in exceptional cases of wide professional experience.) The Ph.D. in Civil Engineering requires 135 graduate hours beyond the baccalaureate (90 hours of coursework and 45 hours of dissertation). Individual options at the doctoral level require certain components of courses and levels.

The dual-master's degree program offered by the Departments of Civil Engineering and Public Works Administration awards candidates the degrees of Master of Science in Civil Engineering and Master of Public Administration upon completion of the program. Students are expected to complete a minimum of 78 hours in both departments. A thesis is not required, but it is expected that an original Policy Paper will be completed during the second year of the program as an integral part of the Policy Problems Seminars (PA 850 and 851). This paper, in addition to fulfilling the course requirement, must be reviewed for approval by a faculty member of the Department of Civil Engineering and the Division of Public Administration. Summer internships are encouraged in this dual program.

CURRENT FACULTY, STUDENTS, GRADUATES

There are seven faculty members in Civil Engineering involved with the programs included in this summary, six of whom split their time evenly between teaching and research, one who is a full-time administrator but devotes 20-30 percent of his time to research, and one who is one-half time in administration but spends 20 percent of his time on research. In the Hydraulics/Hydrology, Sanitary Engineering, and Environmental Engineering Major Options, there are 32 seniors currently enrolled. In the relevant graduate study areas, there are 21 M.S. and five Ph.D. candidates. On the average, the program awards 32 B.S., six to eight M.S. and one Ph.D. degree. Undergraduate and graduate enrollment levels are increasing. Graduates are employed in the private sector (55 percent) and government (45 percent), and the placement record of the department is excellent. Standard grant programs exist for undergraduates, while financial aid to graduate students consists of research grant support and teaching assistantships (80-85 percent) and outside employment or home government subsidies (15-20 percent).

PROGRAM PROJECTIONS

The long-range goals of the Civil Engineering program include increased curriculum offerings and research in remote sensing, hydrology and hydromechanics - all key environmental areas. While the current program is expected to continue, two faculty members (in environmental survey, hydromechanics and hydrology) must be added and laboratory space and support expanded if the status quo is to be maintained. New staff and facilities would vastly increase the capabilities of the department to prepare students for the major, regional environmental questions they must face and answer. Change in environmental programs generally will, in all probability, come in emphasis and not in greater student enrollments.

COURSE DESCRIPTION (SELECTED)*

Civil Engineering:

410 Environmental Pollution and Control - Environmental pollution: the causes and control of air, water, and land pollution in relation to their effects on health, aesthetics, economics and ecology. (U 3 q.h.)

460 Professional Aspects of Civil Engineering - Structure of the civil engineering profession; interaction of civil engineers with the education process, their clients, other professions and the public. (U 1 q.h.)

518 Environmental Quality - Introduction to environmental quality; air pollution; solid waste disposal; water quality and treatment; wastewater characteristics and treatment. (U G 4 q.h.)

519 Applied Hydraulics - Applied fluid mechanics including pressure probes, open and closed conduit flow measurement and devices; tubo-machinery, homologous units, characteristic curves; water hammer; surge; conduits; laboratory experiments. (U G 3 q.h.)

521 Water Distribution and Wastewater Collection - Design of water supply collection, transmission and distribution systems; design of sewage and storm water collection and disposal systems.(UG3qh)

540 Civil Engineering Systems - Basic concepts and methods of systems engineering and application to civil engineering problems in transportation and water resources planning, structural design, and construction management. (U G 4 q.h.)

576 Civil Engineering Economics and Planning - Engineering economics and theories of planning applied to private and public civil works. (U G 4 q.h.)

603 Remote Sensing of Environment - The energies of the natural and cultural environment; current remote sensing systems and case histories of applications in measuring the environment. (U G 4 q.h.)

610 Analysis of Natural and Polluted Waters - A laboratory study of the measurement and interpretation of water quality indices and pollution, parameters including BOD, COD, alkalinity, nutrients, pH, and heavy metals. (U G 4 q.h.)

613 Applied Hydrology - Hydrologic cycle, meteorology, streamflow, evapotranspiration, hydrographs, runoff relations, runoff hydrographs, groundwater, unit hydrographs, flood routing, frequency and duration studies, and application of hydrologic techniques. (U G 4 q.h.)

614 Transport Phenonmena in Water Resources Engineering - Momentum mass and energy transfer; dimensional analysis; laminar and turbulent transport and mixing; techniques applied to water environment; contaminated transport and hydrodynamics, stratification, and outfall mixing. (U G 4 q.h.)

618 Design of Treatment Facilities - Selection and design of processes for the purification of drinking water and the treatment of wastewaters. (U G 4 q.h.)

624 Coastal and Ocean Engineering - Elementary linear and nonlinear wave theory; wave forecasting spectra; forces on fixed submerged structures; beach processes, littoral drift and sediment transport; shore line protection; coastal outfalls and intakes. (U G 4 q.h.)

677 Noise, Pollution and Safety Aspects of Transportation Systems - Vehicle noise and emissions as affected by operating characteristics; noise measurement and abatement techniques; air quality legislation, air pollution; traffic accident analysis. (U G 4 q.h.)

713 Environmental Engineering Measurements - The application of advanced physical and chemical measurement and calculation techniques to environmental engineering problems. (U G 4 q.h.)

714 Environmental Pollution Abatement - Problems, philosophies, principles, and methods of pollution abatement in the total environment; quantitative approaches to waste management in air, water, and land systems. (U G 5 q.h.)

715 Water Resource Systems: Water Quantity - Planning, design, and operation of reservoirs for single and multiple-purpose use, flood estimation and management alternatives, conjunctive use of ground and surface waters. (U G 4 q.h.)

717 Industrial and Municipal Solid Waste Disposal - Characterization and sources of solid waste; solid waste management; collection systems; processing and disposal; and recycle. (U G 3 q.h.)

719 Stream Sanitation - A study of stream quality standards; effluent standards; and the assimilative capacity of natural water bodies. (U G 4 q.h.)

720 Water Resource Systems: Water Quality - Mathematical modeling of conservative and non-conservative pollutants in aquifers, streams, lakes, estuaries and coastal waters and methods for obtaining least cost correction measures. (U G 4 q.h.)

721 Design of Hydraulic Structures - Basic engineering economic studies, water laws design concepts, reservoir engineering, river training, spillways and energy dissipators; irrigation structures, and channel transition design. (U G 4 q.h.)

724 Dynamic Oceanography - Physical and chemical properties of pure and sea water; global energy balance, governing equations, ocean statics, circulation features, stratification, chloride and pollutant distribution; tide prediction and measurement. (U G 4 q.h.)

755 Solid Waste as a Construction Material - Solid waste material characteristics, production and availability; physical-chemical nature; application in soil stabilization, embankment construction, asphaltic pavements and concrete mixtures. (U G 3 q.h.)

795 Seminar in Civil Engineering - Lectures and discussions of current topics related to civil engineering presented by faculty, students, and guest speakers: term paper required. Repeatable to maximum of 3 credit hours. (U G 1 q.h.)

804 Water Resources Engineering Applications of Remote Sensing - Principles and techniques of using remote sensing for acquisition of data in water resources engineering projects and water quality investigations. (G 5 q.h.)

810 Physical Water and Wastewater Treatment Processes - Principles and design of physical processes for water and wastewater treatment including screening, sedimentation, mixing, floatation, and filtration. (G 3 q.h.)

811 Biological Wastewater Treatment Processes - Principles and design of biological processes for wastewater treatment (G 5 q.h.)

812 Chemical and Advanced Wastewater Treatment Processes - Principles of physical-chemical treatment processes for water and wastewater, including coagulation, softening, absorption, nutrient removal and disinfection. (G 5 q.h.)

814 Industrial Wastewater Treatment - Principles of industrial wastewater treatment including wastewater surveys; flow reduction, and segragation and equalization; batch and continuous treatment; instrumentation, and treatment processes. (G 3 q.h.)

820 Advanced Hydrology - Advanced analysis of classical concepts; study of new techniques and concepts developing in modern hydrology; written and oral presentations of critical reviews of current literature. (G 5 q.h.)

850 Seepage in Permeable Materials - Analysis of seepage volume and stresses in connection with excavation, dams, wells, slopes, and subsurface drainage; electro-osmosis. (G 4 q.h.)

Agricultural Engineering:

750 Design of Waste Management Systems - Application of bioengineering principles of pollution control in the design of management systems for wastes from food and fiber production, storage, and processing operations. (U G 3 q.h.)

Chemical Engineering:

671 Legal Aspects of Engineering - Basic legal concepts; the administrative processes as exemplified by environmental regulation; patents, trade secrets; selected topics from the viewpoint of the engineer and scientist. (U G 3 q.h.)

771 Air Pollution - Sources of air pollutants, properties of small particles, chemistry of air pollution, dispersion and deposition of air pollutants, and air pollution control. (U G 3 q.h.)

Geography:

530 Conservation of Natural Resources - Philosophy of resource use; appraisal of resource base; costs of resource development and conservation; resource perception, utilization and alternatives. (U G 4 q.h.)

650 Urban Geography - Origin and growth of cities; structure and function of urban centers, their areal expansion, and intertrade center relations, each examined in relation to city planning. (U G 5 q.h.)

Law:

719 Natural Resources - The nature and incidents of public and private interests in water, minerals, oil and gas; conveyancing of natural resources, and mineral, oil and gas leasing. (P 4 q.h.)

732 Environmental Law - Legal problems relating to the living environment; legal problems of conservation of resources such as forest, wildlife, soil and parks. (P 3 q.h.)

Mechanical Engineering:

636 Nuclear Power Plants - A study of the thermal and mechanical design aspects of nuclear power plants and processes. (U G 3 q.h.)

640 Principles of Environmental Control - A study of the principles of the control of environments for human occupation, occupation by other living beings, the operations of mechanical and electrical equipment, and for the storage and processing of materials. (U G 3 q.h.)

Microbiology:

634 Water Microbiology - A basic study of the relationships and influence of aquatic environments on micro-organisms and the effect of microbial metabolic processes on the quality of water. (U G 5 q.h.)

Natural Resources:

600 Natural Resources Problems, Programs, and Policies - Analytical study of contemporary and future problems of natural resources conservation and programs and policies related to their solution. (U G 4 q.h.)

Nuclear Engineering:

505 Introduction to Nuclear Science and Engineering - Discussions of nuclear energy and nuclear radiation; sources, methods of utilization, and projections for future engineering uses. (U G 3 q.h.)

606 Radiological Safety - General principles of radiation, radioactivity, and protection methodology with emphasis on approved operating, handling and waste disposal procedures, also regulations and biological effects. (U G 3 q.h.)

626 Introduction to Nuclear Power - Nuclear power reactors; the economic and technical aspects of the nuclear power industry. (U G 3 q.h.)

*Instructional Level:
U = Undergraduate
G = Graduate
P = Professional

INSTITUTION: RENSSELAER POLYTECHNIC INSTITUTE

PROGRAM: Environmental Engineering

DEPARTMENT: Chemical and Environmental Engineering

DEGREE: Bachelor of Science (B.S.)   Doctor of Philosophy (Ph.D.)
Master of Engineering (M.E.)
Master of Science (M.S.)
Doctor of Engineering (D.E.)

CONTACT: Dr. David Hansen, Chairman
Dr. William W. Shuster
Environmental Engineering Program
Chemical and Environmental Engineering Dept.
Rensselaer Polytechnic Institute
Troy, New York 12181
(518) 270-6377

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Chemical and environmental engineering are combined as disciplines at the Rensselaer Polytechnic Institute into the Chemical and Environmental Engineering Department. Rensselaer is one of the few institutions of higher education in the United States which offers a baccalaureate degree in environmental engineering. The Environmental Engineering Program builds on a broad base of studies in chemistry, life science, and engineering science in a three-year pre-engineering portion of the program, and during the senior year students receive specialized study in environmental engineering. The senior year consists of a sequence of courses designed around unit processes and integrated laboratory design courses. Employment for graduates of the program may be found in industry, consulting, government, research agencies and teaching.

On completion of the three-year pre-engineering curriculum, an undergraduate may continue to the two-year professional program leading to the Master of Engineering degree. Students electing the professional program may elect any of four options emphasizing water resources, solid waste, air pollution or radiological health. The Master of Engineering degree is awarded on completion of specified programs which are accredited by the Engineers' Council for Professional Development. The Master of Science degree is awarded on completion of a program which is individually arranged and appropriate to the major field. The Doctor of Engineering and Doctor of Philosophy degree programs are also arranged individually and emphasis is placed on advanced study in a specialty, with a major focus on thesis work. At the graduate level, students are encouraged to take cross-disciplinary studies using other Rensselaer courses outside of the department.

The department utilizes extensive research and instructional laboratories with a broad range of process and analytical instrumentation. Water resources laboratories are located at the Fresh Water Institute at Lake George. Current research is conducted in the study of water resources and its subtopics of treatment technology, environmental monitoring, and modelling of water ecosystems. Other environmental engineering research efforts are being directed in the area of air resources, solid wastes, radiological health, and other related areas. Some interdepartmental research is also being conducted with other departments in the areas of environmental acoustics, radiological health, water resources, and bioengineering.

PROGRAM REQUIREMENTS

Students seeking admission at the same level to the baccalaureate program must first be admitted to the university and satisfy the pre-engineering requirements. Junior college transfers can enter the program at the third year as long as their educational backgrounds are equivalent to what is offered during the first two years at Rensselaer. Department officials stated that prospective students should have taken four years of high school mathematics and science and have graduated in the top 10 percent of their class.

The Master of Engineering program, administered by the Professional School is EPCD-accredited, and graduates of other schools may be admitted with advanced standing and may normally complete the degree program in one year, if their baccalaureate engineering degrees are accredited. Master of Engineering candidates must: (1) be admitted to the Professional School of Engineering; (2) fulfull the general requirements; (3) complete the prescribed curriculum in the Professional School satisfactorily, and (4) complete an engineering project.

A total of 133 hours is required for completion of the Bachelor of Science degree in Environmental Engineering. In addition to the three-year pre-engineering program totaling 102 hours, the two-year Master of Engineering program requires completion of an additional sixty-one hours. The doctorate requires completing ninety credits beyond the bachelor's degree and a doctoral thesis or engineering project.

Although Rensselaer has established an Industrial Traineeship Plan, there is no sponsorship under this plan for environmental engineering students. The Chemical and Environmental Engineering Department does participate in a cooperative education program with industry. In the cooperative plan programs, students alternate periods of employment with periods of on-campus education; however, there is no financial support from the sponsor directly to the student's educational program.

Normal federal financial aid programs are available to students at the undergraduate level. At the graduate level, the only source of funding for students is research contracts. Training grants have almost disappeared and one U.S. Environmental Protection Agency fellowship is being funded. In addition, one industrial fellowship is available.

CURRENT FACULTY, STUDENTS, GRADUATES

Ten faculty members are currently involved with teaching and research activities associated with the Environmental Engineering program. Many faculty members are involved in both portions of department's program. It is estimated that there are four and one-half full-time equivalent faculty members each involved with teaching and research.

At the undergraduate level during the pre-professional program, students are not identified as being environmental engineering oriented. While there are about twenty seniors in environmental engineering, this is out of a total of about 800 senior undergraduates in the engineering school. There are no part-time undergraduate environmental engineering students enrolled.

Fifty-four graduate students have chosen to specialize in environmental engineering at Rensselaer. Of these, forty are full-time students; two are female. There are fourteen part-time students taking graduate environmental engineering programs, and of these, one is female. It is estimated that 3½ percent of the undergraduate and 5 percent of the graduate students in the School of Engineering elect environmental engineering.

Within the last five years, an average of twenty-five undergraduates received baccalaureate degrees in environmental engineering at Rensselaer. At the graduate level, within the last three years on an average, twenty students have received master's degrees and three have received doctorates.

With the decline of training grants from the U.S. EPA, Rennselaer has felt less tied to offering specific curriculum specializations to environmental engineering students. Emphasis at the undergraduate level has been placed on providing students with a solid fundamental environmental engineering background. Master's students are required to complete a six-credit thesis, and the topic is usually in the student's chosen area of specialization. Approximately one-third of the master's program includes required fundamental courses. About one-half of the environmental engineering students elect to specialize in the water resources area. One-fourth elect the air option, and one-fourth select the other two remaining areas of concentrations.

Due to increasing governmental cutbacks in hiring, most of the environmental engineering graduates have found employment within private industry (mainly consulting firms.) There are a consistent number of graduates employed by industry involved in the design and manufacture of equipment for environmental control. Other graduates find employment with research groups and within academia.

PROGRAM PROJECTIONS

Although the Rensselaer environmental engineering program is not expected to significantly change in size and emphasis over the next five years, research programs may be expanded. Two additional environmental engineers with air or water resources backgrounds may be recruited for an expanded research program. An environmental science degree may be developed at Rensselaer within the School of Science as the Biology Department is active in environmental studies.

Rensselaer officials expect enrollment in environmental engineering to begin to level out, and keep pace with population trends. More emphasis in the next few years is expected to be in the application of chemical processing in the pollution control areas. The curtailment of the EPA training grant program has had a serious effect on the number of students entering environmental engineering graduate programs at Rensselaer. Departmental officials feel that there is a need to reinstate the EPA training grant program.

A main attraction of the Rensselaer environmental engineering program is the fact that it is one of the strongest undergraduate programs in environmental engineering in the United States. The graduate program is also considered to be one of the premier environmental engineering programs in the nation.

COURSE DESCRIPTION

32.405 Unit Operations in Environmental Engineering - A study of the physical processes, termed unit operations, that are common to air, water, and land pollution control systems. (3 s.h.)

32.406 Unit Processes in Environmental Engineering - The study of several physical-chemical and biological processes encountered in environmental pollution control and water supply. (3 s.h.)

32.407 Environmental Acoustics - A study of man's total sonic environment. (3 s.h.)

32.409 Water and Wastewater Engineering - The topics studies are: estimates of water demands, water supply sources, water quality criteria, transmission and distribution of water, water pumping and storage systems, rural water supply and other topics. (3 s.h.)

32.415, 32.416 Environmental Engineering Laboratory I & II- Experiments are performed in the areas of water, wastewater, solid wastes and air pollution. (2 s.h. each)

32.423 Air Pollution: Sources and Effluents - Fundamental aspects of air pollution with emphasis on emissions from major stationary and mobile sources (automobiles). (3 s.h.)

32.431 Solid Waste Engineering - Classification and characteristics of solid wastes, the need for and rating of solid waste management systems, design of municipal refuse collection and transfer systems, methods and costs of solid waste disposal, and other subjects. (3 s.h.)

32.442 Industrial Waste Treatment and Disposal - Physical, chemical and biological characteristics of industrial wastes. (3 s.h.)

Graduate Courses:

32.601 Public Health I - Occurrence and control of communicable diseases; principles of epidemiology and biostatistics and their application, emphasizing the relationship with environmental factors; air pollution sources and health effects. (2 s.h.)

32.602 Public Health II - International, federal, state and county health organizations, responsibilities, and functions; water quality management and public water supplies; solid wastes management; radiological health controls; air resources controls and management. (2 s.h.)

32.603 Chemistry for Environmental Engineers - The weekly 3-hour laboratory emphasizes analytical measurements using instrumental techniques; most experiments are drawn from the water and wastewater field, a few from air pollution. (3 s.h.)

32.611 Water Resources - Elements of meteorology and hydrology. Precipitation, runoff, stream flow, watershed losses, unit hydrograph, and groundwater problems. (3 s.h.)

32.612 Physical Chemical Waste Treatment - The application of theoretical principles and pilot plant data to the design and operation of advanced waste treatment systems. (3 s.h.)

32.614 Stream Pollution Control - The economic aspects of water pollution; health aspects of bacterial pollution. (3 s.h.)

32.616 Environmental Impact Analysis - Studies related to the evaluation of the impacts of major actions by state and federal agencies on the quality of human environment. (3 s.h.)

32.620 Atmospheric Chemistry - The course presents important thermodynamic and kinetic aspects of reactions in the atmospheric layer. (3 s.h.)

32.622 Air Pollution Meteorology - Investigation of atmospheric processes of particular importance in dealing with the environmental problems of air pollution. (3 s.h.)

32.624 Air Pollution Control - The major approaches to air pollution control are discussed from three different viewpoints. (3 s.h.)

32.634 Environmental Radiation Safety Controls - Consideration and control of the health hazards peculiar to the atomic industry. (4 s.h.)

INSTITUTION: STATE UNIVERSITY OF NEW YORK AT BUFFALO

PROGRAM: Water Resources and Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science (B.S.)
Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Dale D. Meredith
Program Director
Water Resources and Environmental Engineering
Department of Civil Engineering
State University of New York at Buffalo
4232 Ridge Lea
Buffalo, New York 14426

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Civil Engineering offers a program in Water Resources and Environmental Engineering for both undergraduates and graduates. Emphasis in the M.S. program is on developing a basic understanding of both water quantity and water quality principles in order to deal with the water management problems. After learning the principles, students then take courses emphasizing methodologies and applications. Undergraduates are prepared for employment with city, state and federal departments of transportation, planning, conservation, water resources and public works, consulting firms, and industrial organizations. The Master of Science degree program provides an extension of undergraduate education by an additional 30 credits in a particular area of student interest such as environmental engineering.

Research in the field of Water Resources and Environmental Engineering is viewed as a joint activity between both the students and the staff. The following categories of research activities are ongoing: Waterbody hydronamics; river, stream, and lake basin management; fate of pollutants in the environment; water and wastewater treatment and disposal; and development of simulation models and use of systems methodology. Funding sources for research come mainly from the National Oceanographic and Atmospheric Administration (Sea Grant), the U.S. Dept. of the Interior (OWRT), and the National Science Foundation.

The program is currently preparing to move into a new 8000 square foot laboratory complex which will include facilities for sanitary engineering investigation. Students also have access to CDC Cyber 173 computer with remote terminals for simulation models research.

PROGRAM REQUIREMENTS

In order to enter the undergraduate Civil Engineering program, students should have high school preparation including mathematics through trigonometry, a course in solid geometry, a semester in physics, and chemistry or biology. Transfer students must have completed one full semester of college level work prior to application. For admission to the M.S. degree program, students are usually not admitted if they had not achieved a 2.75 on a 4.0 point system as undergraduates. Admission for the doctorate is not accepted if the student's previous scholarship level is below 3.0.

The Bachelor of Science degree requires 128 hours of which 32 must be in Civil Engineering. The requirements in the final two years for a Bachelor's Degree in Civil Engineering are: four Civil Engineering core courses; four Civil Engineering courses from a major concentration area (Water Resources and Environmental Engineering); four technical elective courses; and four non-technical elective courses.

The M.S. program is composed of a common first semester core of three courses emphasizing principles and the remainder of the program is filled with courses emphasizing methodologies and applications. The degree can be completed in two ways: 30 credits of advanced course work and a comprehensive examination; and 24 to 27 credits of advanced course work with a 3 to 6 credit project or thesis. No comprehensive examination is required if the second method is chosen.

The doctorate requires intensive study leading to an original contribution to the state of knowledge in the field of Water Resources and Environmental Engineering. A committee guides this study and is finished by the submission and oral defense of the dissertation.

Seventeen full-time assistantships are available to graduate students in the program during the 1977-78 school term. The financial aid package includes teaching and research assistantships which include tuition remission. Special fellowships are also available on a university-wide competitive basis.

CURRENT FACULTY, STUDENTS, GRADUATES

Four full-time faculty members contribute to the teaching of the program's curriculum. All faculty in the program conduct research which constitutes about one-half of their time.

There are currently forty undergraduates enrolled in the program and all are full-time (2 are female). Enrolled at the M.S. level are a total of 45 students of whom 22 are full-time (all male) and 23 are part-time (1 female). Approximately 35 students annually receive the B.S. degree, 9 to 10 earn annually receive the M.S. degree, and one to two receive their doctorates. The program is in the process of expanding in both enrollment and facilities.

Many students continue on for advanced degrees and several have entered doctorate programs offered by Cal Tech, SUNY at Buffalo, and the University of Delaware. Virtually all graduates find employment directly in their field. About one-half each find jobs in the private and government sectors. Most finding jobs in the private sector mainly obtain them with consulting firms.

The program's students prepare short resumes and they are compiled into a package which are circulated with firms located around New York state. The firms contact the department if they are interested in hiring a student for either summer or permanent employment. This procedure is considered to be very effective.

PROGRAM PROJECTIONS

This program is anticipated to expand in both enrollment and facilities. It is a strong program and with the addition of the new laboratory, additional students will be recruited for laboratory research. Two new faculty members are expected to be hired within the next two years to complete the program and meet the requirements to handle additional students. An environmental engineer with research interests in waste disposal and land or urban hydrology will be recruited for the fall term, 1978 to teach physical and chemical treatment courses. Another faculty member with a civil engineering background will be recruited by the fall term 1979 to teach waste disposal or urban hydrology courses.

COURSE DESCRIPTION

(the following is a partial listing of courses)

CIE 440 Water and Wastewater Engineering - Water quality parameters, criteria, and standards; water quality in lakes and streams; principles of water and wastewater treatment processes; in-depth study of common unit operations. (4 s.h.)

CIE 441 Water Resources Engineering - Comprehensive problem-oriented study of water resource analysis including hydrology and probability concepts in design; reservoirs, dam, and spillways; and other topics. (4 s.h.)

CIE 442 Water and Wastewater Engineering II - Introduction to aquatic chemistry and microbiology; advanced study of water and wastewater treatment processes and treatment plant design; population prediction, design of storm and wastewater collection systems. (4 s.h.)

CIE 461 Introduction to Air Pollution Engineering - This course will provide the students with a basic understanding of prevalent problems in our air environment as well as technologies and control measures necessary for remedying these problems. Other topics will be discussed. (4 s.h.)

Graduate courses:

CIE 500A Optimization of Water Pollution Control Systems - The study of procedures and techniques for optimal design and operation of water pollution control systems. (3 s.h.)

CIE 509 Civil Engineering Systems Analysis - Emphasis is placed on the analysis of civil engineering systems following the systems approach. Areas of application include structural design, environmental systems, water resource systems, transportation and traffic systems; hydrology and urban systems. (3 s.h.)

CIE 542 Free surface Flow - Study of water bodies in which gravity is a dominant force; formulation of basic equations governing steady and unsteady motions; boundary resistance; gradually varied flow; rapidly varied flow; flood routing; methods of analysis. (3 s.h.)

CIE 544 Coastal Engineering - Application of water-wave hydrodynamics to engineering problems in the near shore coastal zone. (3 s.h.)

CIE 552 Water Resources Planning and Development - Consideration of economic, financial, and environmental analysis techniques and their use in planning for development of flood control, water supply, storm and land drainage, navigation, hydroelectric power, water quality control, recreation, and fish and wildlife enhancement. (3 s.h.)

CIE 554 Seminar in Water Resources and Environmental Engineering - A weekly seminar for students and faculty interested in water resources and environmental engineering. (3 s.h.)

CIE 567 Advanced Concepts in Waste Treatment - Advanced study of selected unit processes of waste treatment. Topics are numerous, including, least cost design of activated sludge wastewater treatment process; design of denitrification processes; analysis of existing one and two stage activated sludge processes; and others. (3 s.h.)

CIE 569 Sanitary Engineering - Covers the operations and design of water and wastewater treatment facilities. (3 s.h.)

CIE 570 Water Quality Principles - Introduction to environmental chemistry and microbiology. Chemical and biological processes in natural waters. (3 s.h.)

INSTITUTION: SYRACUSE UNIVERSITY

PROGRAM: Chemical Engineering

DEPARTMENT: Chemical Engineering and Materials Science

DEGREE: Bachelor of Science (B.S.)
Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. James A. Luker
Dean, College of Engineering
Syracuse University
Syracuse, New York 13210
(315) 423-4341

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The chemical engineering program offers B.S., M.S. and Ph.D. degrees with emphasis on environmental controls in the areas of air, water, and wastewater. The undergraduate program has an option available in environmental systems.

Chemical engineering was established as a program study in 1914 and began offering environmental courses over twenty years ago. This gradually evolved into the environmental systems option. The program prepares students for careers in the design, sales, and research of environmental/emissions control systems. Support facilities include an environmental monitoring instrumentation lab and the lab facilities of the Chemical Engineering Department.

PROGRAM REQUIREMENTS

General requirements for undergraduate admission include a high school diploma along with scores from either the Scholastic Aptitude Test or the American College Test. Admission to the M.S. program requires an acceptable undergraduate degree with a cumulative average of 3.0 on a four-point scale, and the Graduate Record Exam. The Ph.D. program generally requires an acceptable M.S. degree. An acceptable degree is usually considered to be one in an engineering discipline.

The undergraduate option in environmental systems is flexible and allows students to pursue their own areas of interest. Included in the one hundred and twenty to one hundred and twenty-nine credit hour program are twenty-two hours in chemistry, twelve in math, eight in physics, six in English, three in engineering and fifteen in environmental electives.

A master's degree can be obtained with or without a thesis. The thesis program requires twenty-four hours of course work or independent study, with a minimum of twelve in chemical engineering. Without a thesis, the degree requires at least thirty hours of study of which fifteen must be in chemical engineering, including three hours of research or independent study.

Requirements for the Ph.D. include a minimum of ninety hours of credit beyond a bachelor's degree, with between eighteen and thirty-nine credit hours toward a dissertation. At least twenty-four credit hours must be in chemical engineering and twelve hours in a relevant minor field.

CURRENT FACULTY, STUDENTS, GRADUATES

A total of seven faculty members participates in this program, who divide their time almost evenly between teaching and research. Funding for research is provided by the National Science Foundation and New York State.

Currently there are ninety-five undergraduate and twenty graduate students in the program. Many students are career change, coming from the fields of biology and chemistry. About 60 percent of the undergraduates are in-state residents while only about 15 percent of graduate students are in-state. Recruitment is normally done by the university but the program does recruit some of its undergraduates for the graduate program. Some of the undergraduates receive financial assistance in the four of university scholarships based upon need. Graduate student assistance is available in research assistantships and fellowships.

The average number of graduates in both the undergraduate and graduate programs is about fifteen per year with slight variation. About 25 percent of the B.S. students go on to further education and approximately one-third of the M.S. degree graduates continue. Graduates generally experience no difficulties in finding employment, and it is estimated that almost 95 percent work in private industry. Most job placement is informal, accomplished through faculty contacts.

PROGRAM PROJECTIONS

No increase in program activities or faculty is anticipated for the foreseeable future.

COURSE DESCRIPTION (SELECTED)

CEN 511 Environment Monitoring Instrumentation - Experimental techniques of sampling and analysis of gaseous, liquid and solid waste. Principles and operation of modern instruments to measure very low concentrations of air and water pollutants, including the evaluation of typical data. (3 s.h.)

CEN 532 Aerosol Technology - Mechanical, electrical, and physiochemical behavior of aerosol particles. Theories of disposition and filtration of particles from gases, and experimental methods for measuring particle size distributions. (3 s.h.)

CEN 545 Physiochemical Methods in Waste Treatment - General survey on the applicability of chemical engineering unit operations and unit processes in fluid waste treatment. Membrane process, including electrodialysis and reverse osmosis, IPC (Independent Physical and Chemical) process of waste treatment, coagulation, deep bed filtration, and carbon column operation. (3 s.h.)

CEN/MEE 547 Chemistry and Transport of Air Pollutants - Photochemical, thermal, and heterogeneour reactions of gaseous pollutants, transport equations, air pollution climatology, dispersion modeling, and forecasting potential air pollution occurrences. (3 s.h.)

CEN 573 Principles and Design in Air Pollution Control - Fundamental principles of pollution control, design of control processes and equipment for gaseous and particulate pollutants. (3 s.h.)

INSTITUTION: UNIVERSITY OF MISSOURI - COLUMBIA

PROGRAM: Sanitary Engineering

DEPARTMENT: Civil Engineering

DEGREES: Bachelor of Science (B.S.)
Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. W. R. Kimel, Dean, College of Engineering
Dr. John T. O'Connor, Head, Department of Civil Engineering
University of Missouri - Columbia
Columbia, Missouri 65201
(314) 882-4375

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Civil Engineering is one of eight departments in the UMC's College of Engineering. There are five basic areas of specialization: structures, environmental engineering (water supply, wastewater treatment, solid waste disposal, air pollution control), transportation, construction management, municipal engineering.

The Kansas City Graduate Engineering Program (UMKC) provides evening courses to employed engineers earning M.S. degrees in chemical, civil, electrical, industrial, mechanical and nuclear engineering. This began in 1964 and in 1976-77, 46 degrees were awarded through the UMKC program.

The programs are accredited by the Engineers' Council for Professional Development (ECPD).

PROGRAM REQUIREMENTS

A B.S. requires 126 hours of which at least 42 hours are electives. Freshman and sophmore courses have commonality with other departments. The junior year is seen as the time when the student is given an overview of civil engineering. The senior year provides an opportunity to study either a broad program or a speciality area in depth. An undergraduate cooperative program is also available in which semesters of work and school are alternated, usually beginning after the freshman year.

The undergraduate option in environmental engineering includes 21 hours of technical electives. An introductory course in sanitary engineering (391) and four core courses (392, lab, lab and field, study, theory) are required.

An M.S. requires 30 hours; Ph.D. 60 hours. Each graduate program is tailored to the individual student's interest.

CURRENT FACULTY, STUDENTS, GRADUATES

All workshops, seminars, etc. are handled through the Engineering Extension division of UMC's College of Engineering. Seventy-one courses serving 216 students (FTE) were offered during the 1976-77 year.

Requests for grants are handled through the Engineering Experiment Station. Forty-eight research projects in civil engineering were funded in 1976-77 totaling $450,340. Twenty-three were in Sanitary Engineering. Areas of emphasis are organics, viruses, water quality deterioration in water distribution systems, and rural water supplies. Proposals have also been funded through NSF, Missouri State Highway Department, OWRR, ERDA, Monsanto, and the Army.

A $50,000 EPA grant was awarded to the water pollution team at UMC to support the construction of a mobile laboratory containing two water treatment plants. This laboratory on wheels can be moved to any point in the country where its resources will enable scientists to isolate specific viruses for observation and analysis before and after adding disinfectants to the water.

Engineering students publish the Missouri Shamrock quarterly. "Emphasis on Energy" was the December, 1977 issue. Articles dealt with nuclear power, coal gasification, resource reclamation and included a debate on the merits of nuclear energy. The College of Engineering publishes the Newsletter monthly.

One hundred thirty-seven scholarships were administered by the College of Engineering Scholarship Committee in 1976-77. Thirty-one were to women. Other financial aids include university, federal and state grants, work-study, and loans.

There are 15 undergraduates, 12 masters, and 12 Ph.D students enrolled in sanitary engineering. Graduates number 27 (15 undergraduates, 10 masters, and 2 Ph.D.'s). Presently 180 of the undergraduate engineering students are women; 35 are in civil engineering.

Undergraduate students find employment in consulting (50%), government (25%), industry (25%). Graduate student employment includes government (20%), consulting (33%), industry (33%), other (14%).

PROGRAM PROJECTIONS

The programs will continue to increase in number of students and research in spite of the limited and antiquated facilities.

ADDITIONAL INFORMATION

The Advisory Council for the UMC College of Engineering has 31 members and represents eight states and the District of Columbia.

The Industrial and Technical Referral Center (ITRC) has as its primary function the assisting of Missouri organizations, institutions, and citizens locate published information and sources of professional expertise related to identified specific needs. The primary services of the Referral Center are to provide technical information and assistance and library loan services in response to requests from businessmen and public officials which are relayed to the Center by state wide extension staff. In 1976-77, 1,177 requests (presentations, loan services, plantvisits, etc.) were handled.

Monthly environmental engineering seminars are held in the evening. Students supply ideas for the topics to be discussed. The faculty has dinner with the speaker before the actual presentation and a question and answer period follows. Between 50 and 90 people attend and the newspapers usually cover the seminar. A recent topic was "Spontaneous Pneumothorax and Air Pollution."

COURSE DESCRIPTION

344 Analysis of Water-Resource Systems - Applications of hydrology, hydraulic and sanitary engineering, and economics to water-resource design problems considering man and his environment. Utilization of methods of systems analysis. (3 s.h.)

348 Environmental Sanitation - Principles of environmental sanitation as applied to community and rural problems of water supply, sewerage, housing, waste disposal, food sanitation, etc. (3 s.h.)

349 Environmental Sanitation Practice - Companion course to 348, including group evaluation of environmental controls, laboratory instruction and field practice. (3 s.h.)

365 Engineering Administration - Engineer's relation to management in connection with promotion, design, construction, operation, administration of industries, public works. Engineering economy. (3 s.h.)

391 Environmental Engineering--Water - Principles and practices of water treatment and distribution and wastewater collection, treatment and disposal. (3 s.h.)

392 Water and Wastewater Treatment Processes - Planning, layout and design of municipal and industrial water and wastewater treatment systems. (3 s.h.)

394 Sanitary Engineering Chemistry - Applications of chemical theory and concepts of operations commonly employed in water and wastewater treatment to pollution from persistent chemicals and to specific control parameters. (3 s.h.)

395 Water Quality Analysis - Chemical, physical and biological methods for analysis of streams, lakes, wastewaters and water supplies and their use in water quality management. (3 s.h.)

492 Sanitary Engineering Operations - Applications of physical and chemical fundamentals to problems of water and wastewater treatment. (3 s.h.)

493 Sanitary Engineering Processes - Applications of biological and chemical fundamentals to problems of water and wastewater treatment. (3 s.h.)

496 Design of Water and Wastewater Treatment Facilities - Development of design criteria and their application to the design of water and wastewater treatment facilities. (3 s.h.)

498 Engineering Aspects of Water Quality - Theoretical aspects of biological, chemical, physical processes: applications in water, wastewater, industrial-waste treatment processes, natural water systems; chemical equilibria, flow models; reaction kinetics on process design, pollutants. (3 s.h.)

INSTITUTION: UNIVERSITY OF NEBRASKA

PROGRAM: Civil Engineering (undergraduate)
Sanitary Engineering (graduate)
DEPARTMENT: Civil Engineering
DEGREE: B.S. in Civil Engineering
M.S. in Sanitary Engineering
Ph.D. in Sanitary Engineering (degree available though program is not established)

CONTACT: Dr. Edward Wilson, Chairman
Department of Civil Engineering
University of Nebraska
Lincoln, Nebraska 08508
(402) 472-2371

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Historically, the environmental program at the University of Nebraska is well-established. The Civil Engineering Department offers a M.S. degree in Sanitary Engineering and a B.S. degree in Civil Engineering which includes coursework in sanitary engineering. While the faculty anticipate an expansion of the program to incorporate more fully the Omaha campus, they foresee no shift in the program objectives: to train application-oriented professionals and to provide continuing education opportunities for those persons already in the field.

Facilities include a 24-station teaching laboratory, three research rooms, a walk-in constant temperature chamber, and a preparation room. Teaching loads prohibit release time for research though faculty continue to publish actively. Dr. Mark Hammer has authored or co-authored two textbooks with recent editions (Water and Wastewater Technology and Water Supply and Pollution Control). Research funding is large in-house.

PROGRAM REQUIREMENTS

There are no special prerequisites for entrance into the undergraduate degree program. To gain admittance to the graduate programs, a master's degree applicant must have a 2.5/4 and a doctoral applicant, a 3.0/4. The GRE is not required for graduates of accredited engineering programs. Provisional admission is possible for students without adequate undergraduate preparation. Foreign students must score at least 450 on the TOEFL examination. Non-engineers must make up the following prerequisites: mathematics, undergraduate sanitary engineering courses, fluid mechanics, and hydrology.

To obtain the undergraduate degree, one must complete 134 semester credit hours; the master's degree, 30 semester hours with thesis or 36 without thesis; and the Ph.D., 36 months of residence beyond the master's degree.

CURRENT FACULTY, STUDENTS, GRADUATES

The University of Nebraska's sanitary engineering program has two full-time faculty members paid by the Civil Engineering Department, one full-time position open at the Omaha campus, and one full-time faculty member whose salary is budgeted in the Nebraska Water Resources Center. The dean of the College of Engineering is also a sanitary engineer.

The undergraduate civil engineering students number approximately 450 in FTE units. There are eight full-time students and six part-time students enrolled are recruited primarily from Nebraska's undergraduate program. Eight to ten students complete graduate study each year, a figure which represents a decline over the last several years but which should increase to 15 with the development of the Omaha campus program.

Of the four teaching assistantships available in the Civil Engineering Department to graduate students, one is usually awarded to a student in sanitary engineering. Occasionally graduate students are funded through outside research projects, and two graduate students are currently supported by EPA fellowships (one in wastewater and one in solid waste). At the undergraduate level, students may participate in a college-coordinated cooperative program in which they work for a firm and attend school in alternating semesters.

In seeking employment, graduates place themselves, depend on faculty contacts, or utilize the university's placement office. They find jobs in government at state and municipal levels and with consulting firms, equipment manufacturers, and other private employers. Few students seek the Ph.D.

PROGRAM PROJECTIONS

No drastic changes in curriculum are anticipated; the faculty maintain that the program is flexible enough to meet the changing needs and objectives of training professionals in water-related fields. Despite technological advances and social mandates with regard to the environment, faculty at Lincoln contend that their program will continue to produce quality personnel. The direction of the program in Omaha will depend in part on the qualifications of the person hired to fill the position open on that campus. The expansion to that urban setting should increase the services and resources available to students.

COURSE DESCRIPTION*

Agricultural Engineering:

AE 854 Soil and Water Conservation Engineering - Application of hydrologic, water utilization, water erosion control, and wind erosion control principles to land management problems. Analysis and design of soil and water conservation systems. (3 s.h.)

AE 941 Animal Waste Management - Concepts of industrial and municipal waste management as applied to agricultural waste; design parameters for livestock feeding systems and various methods of treating livestock waste and runoff from agricultural land operations. (2 s.h.)

AE 954 Hydrologic Modeling of Small Watersheds - Mathematical modeling of the runoff process for small rural and urban watersheds. Appraisal of techniques for estimating runoff volume and peak discharges for ungaged watersheds; hydrographs, and frequency relationships of rainfall and runoff. (2 s.h.)

Chemical Engineering:

ChemE 883 Air Pollution, Assessment and Control - A survey of the present status of the air pollution problem and the application of engineering and scientific principles to its practical and effective coordinated control. (3 s.h.)

Metallurgical Engineering:

ME 873 Corrosion - Fundamentals of corrosion engineering, underlying principles, materials, selection and environmental control. (3 s.h.)

Civil Engineering:

CE 226 Sanitary Engineering I - Introduction to water supply engineering encompassing the quality of water and water sources, distribution systems, and treatment methods. (2 s.h.)

CE 327 Sanitary Engineering II - Introduction to wastewater collection, treatment, and disposal systems. Included are the design of sanitary and storm sewers, characteristics of wastewater, stream and lake pollution, and treatment of domestic wastewaters. (3 s.h.)

CE 351 Hydrology - Introduction to the principles of hydrology, with emphasis on the components of the hydrologic cycle: precipitation, evaporation, groundwater flow, surface runoff, infiltration, drainage basin characteristics, streamflow, and precipitation-runoff relationships. (3 s.h.)

CE 400/800 Environmental Quality and Control--Land, Air, and Water - Application of the principles of ecology, engineering, and planning to the control and management of the physical environment (land, air, and water) including land and water ecosystems, air and water pollution, and environmental planning. (3 s.h.)

CE 426/826 Environmental Pollution Control - An introduction to the engineering principles of control of air pollution, solid wastes, and radioactive wastes in relation to the total environment. Interrelation of air, water, and land waste disposal methods are stressed. (3 s.h.)

CE 428/828 Application of Chemistry to Sanitary Engineering - Applications of chemistry in the analyses and treatment of water and wastewater. (3 s.h.)

CE 429/829 Applications of Microbiology to Sanitary Engineering - Applications of microbiology related to the treatment of wastewater and the bacteriologic examination of water and wastewater.

CE 452/852 Water Resources Development - Theory and application of systems engineering with emphasis on optimization and simulation techniques for evaluating alternatives in water resources developments related to water supply, flood control, hydroelectric power, drainage, water quality, water distribution, irrigation, and water measurement. (3 s.h.)

CE 454/854 Hydraulic Engineering - Fundamentals of hydraulics with applications of mechanics of solids, mechanics of fluids, and engineering economics to the design of hydraulic structures. Continuity, momentum, and energy principles are applied to special problems from various branches of hydraulic engineering. (3-4 s.h.)

CE 456/856 Advanced Hydrology - Advanced topics in hydrology including parametric and stochastic processes and systems analysis of hydrologic problems with particular emphasis on the application of techniques in the design of engineering projects. (3 s.h.)

CE 457/857 Engineering Hydrology - Introduction to the principles of engineering hydrology, with emphasis on the components of the hydrologic cycle: precipitation, evaporation, surface runoff, infiltration, drainage basin characteristics, stream flow, and precipitation runoff relationships. Emphasis is placed on utilizing these variables in forming engineering judgment. (3 s.h.)

CE 458/858 Groundwater Engineering - The application of engineering principles to the movement of groundwater. The influence of the physical and geologic environment on groundwater hydraulics. Water well hydraulics and aquifer evaluation. Emphasis is placed on practical groundwater engineering problems. (3 s.h.)

CE 910 Groundwater Hydrology - Fundamentals of groundwater flow, quantitative aspects of the occurrence and movement of groundwater, hydraulics of wells and well systems, recharge, seepage, salt intrusion, and groundwater models. (3 s.h.)

CE 911 Advanced Hydraulics - Advanced studies in theoretical and applied hydraulics, involving applications of hydrostatics and hydrodynamics to problems of hydraulic design. (2-6 s.h.)

CE 913 River Engineering - Gradually and rapidly varied flow in open channels, river control and navigation considerations, sediment transport and river models, unsteady flow. (3 s.h.)

CE 914 Water Resources Planning - The techniques of comprehensive water resources planning considered relative to social patterns, political structures, economic objectives, technical requirements, and legal constraints. (3 s.h.)

CE 915 Water Resources Engineering - Techniques for relating economic objectives, engineering analysis, and government planning. (3 s.h.)

CE 916 Interdisciplinary Seminar in Engineering: Economic and Legal Aspects of Water Resources Systems - Current and historic aspects of water law, hydrologic and engineering principles applied to water resource systems, governmental policies and planning. (3 s.h.)

CE 926 Advanced Water Treatment - Water quality, theory of water treatment, and design of water treatment plants. A study of new methods of water reclamation. (3 s.h.)

CE 927 Advanced Sewage Treatment - The characteristics of domestic wastes, theory of sewage treatment, and design of sewage treatment plants. A study of advanced waste treatment processes. (3 s.h.)

CE 928 Industrial Waste Treatment - The characteristics of industrial wastes, waste recovery and reuse, treatment methods and ultimate disposal. (3 s.h.)

CE 929 Industrial Waste Laboratory - The determination of the characteristics of industrial wastewaters, and evaluation of treatment methods, including field surveys, laboratory analyses and pilot plant studies. (1 s.h.)

CE 930 Water Quality and Pollution - A comprehensive study of water quality criteria and standards and the effects of various water pollutants upon the aquatic environment. (3 s.h.)

CE 899 Masters Thesis - (6-10 s.h.)

CE 999 Doctoral Dissertation - (cr. arr.)

Geology:

Geol 889 Hydrogeology - Principles of flow through porous media with emphasis on basic classical solutions, flow-net analysis, and elementary modern numerical solutions that aid in the analysis and development of groundwater supplies. (3 s.h.)

Life Sciences:

LifeSci 859 Limnology - Field trips, assigned readings. The physical, chemical, and biological processes that occur in freshwater; a study of the organisms occurring in freshwater and their ecology; the biological productivity of water and its causative factors; eutrophication and its effects. (3-4 s.h.)

*800-level courses and higher are graduate courses; 400-level courses are open to senior undergraduates.

INSTITUTION: UNIVERSITY OF PITTSBURGH

PROGRAM: Environmental and Sanitary Engineering

DEPARTMENT: Civil Engineering

DEGREE:
Bachelor of Science (B.S.)
Master of Science (M.S.)
Doctor of Philosophy, Civil Engineering (Ph.D.)

CONTACT:
Dr. Joel I. Abrams
Chairman of Civil Engineering Department
University of Pittsburgh
Room 949 Benedum Hall of Engineering
Pittsburgh, Pennsylvania 15260
(412) 624-4141

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Civil Engineering first started granting degrees in 1846 and fields of specialization are currently offered in Sanitary Engineering, Water Resource Engineering, and Mine Environmental Engineering and Reclamation. Graduates are employed in positions involving water resources, water supply, waste disposal, air pollution and environmental sanitation. Many graduates find positions with consulting engineering firms (including sales) in research, teaching, and governmental agencies.

Work for full-time students and a complete part-time program are strong points of the Master's degree program. Water resources and environmental engineering are specialty areas in the doctoral program and active research is on-going in both of these areas.

The Environmental and Sanitary Engineering program emphasizes research and courses in the following areas:
Chemistry and biology;
Water analysis for water quality control;
Pollution and control of natural waters;
Unit processes and operations applied to the design of water and wastewater treatment plants;
Solid waste disposal;
Disposal of sludges and concentrates;
Economics;
Administration of sanitary engineering facilities; and
Basin studies and regional environmental planning.

The Department's Sanitary Engineering Laboratories have the necessary equipment and instrumentation for determining all the

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standard wet chemical and microbiological analyses of water and wastewater. Two walk-in incubators and all the latest equipment for the newer sophisticated instrumental techniques are included in these facilities.

PROGRAM REQUIREMENTS

Applications to the graduate program may be considered on an individual basis, but for the applicant who is a recent graduate with a degree from a school accredited by the Engineer's Council for Professional Development (EPCD), admission is granted on the basis of the undergraduate record, and usually an applicant with a B average will be granted admission.

At the undergraduate level, electives are available during the sixth, seventh, and eighth terms to enable a student to pursue an individualized program in the environmental and sanitary engineering area. The Bachelor of Science degree requires completion of 121-123 credits and the undergraduate program is noted for its flexibility in accomodating student interests in environmental and sanitary engineering.

Graduate students prepare a plan of study during their first term and assistance is provided by a faculty advisor. The Master of Science degree is offered with a thesis and a non-thesis option. The thesis option requires completion of a minimum of 24 course credits (eight courses) plus a thesis (six credit minimum). Students electing the non-thesis option are required to complete ten courses for 30 course credits (minimum) and prepare a three credit project. Graduate Preliminary Examinations are given to determine the admission of a marginal case. A Comprehensive Examination is given to all non-thesis program students and to some thesis program students. A Final Oral Examination is given to evaluate the findings of the student's M.S. thesis or project and related course work. Graduate research assistants are required to write a thesis upon recommendation of the advisor and project supervisor.

In order to complete the requirements for the Doctor of Philosophy degree, a minimum of 30 course credits (ten courses) in a major area, a minimum of 18 course credits (6 courses) in a minor area (one or two minor areas, but one outside the Civil Engineering Department), a minimum of six course credits (two courses) in Analytical Techniques, and a minimum 18 credits of dissertation are required. A Plan of Study and Proposal Conference is administered by the faculty advisor and a member of the faculty in the student's major and minor areas of interest. All Ph.D. students take a Comprehensive Examination toward the end of their course work and the Final Oral Examination of three hours duration, is administered by the Doctoral Committee.

A wide variety of financial aid packages are available to graduate students enrolled in the School of Engineering. Fellowships are offered to exceptional students as an unrestricted grant. Traineeships are offered in selected areas and there are usually restrictions on the courses which are allowed to be taken. Tuition scholarships provide for partial or full remission of tuition. Research assistantships are awarded as research contracts and teaching assistantships and teaching fellowships are awarded from department funds for assistance in laboratories, recitation sections, and for other teaching duties.

CURRENT FACULTY, STUDENTS, GRADUATES

Eight faculty members teach the environmental and sanitary engineering courses offered by the Civil Engineering Department. Approximately one-half of their time is devoted to research activities. Funding for research comes from the National Institutes of Health, the Department of Energy (ERDA), the National Science Foundation, and the American Iron and Steel Institute. A joint U.S. Environmental Protection Agency and American Iron and Steel Institute project on industrial wastes will be forthcoming to the Department. Most research work by faculty in the areas of heavy metals (using biological treatment to remove heavy metals) and in the pollution effects resulting from energy production and conversion.

The Civil Engineering Department has 320 Bachelor of Science students (including 40 female) enrolled in the fall term, 1977 and 35 students (five female) have elected to take environmental and sanitary engineering courses as electives. About 100 students receive the B.S. degree annually.

At the graduate level, there are a total of 220 students (70% part-time) enrolled in the M.S. and Doctor of Philosophy degree programs in the Civil Engineering Department. Approximately 175 are M.S. candidates and 35 are Ph.D. candidates. Of students electing the environmental and sanitary engineering option, 60 are M.S. students (3 female) and 20 are Ph.D. students (one female). Approximately 35 M.S. degrees and three to four Ph.D.s are annually granted by the department. In the environmental and sanitary engineering area, about 15 of the 35 M.S. graduate and two Ph.D.s are students participating in the program.

About forty percent of the B.S. students and fifteen percent of the M.S. students continue on for advanced degrees. Most students choose to continue their studies at the University of Pittsburgh. There are many part-time students enrolled in the M.S. degree program mainly because of the availability of jobs in the area. Virtually all graduates find employment directly in their field and it is estimated that 80 percent find jobs in the private sector and 20 percent find positions in government. Most finding private sector jobs are employed in consulting engineering firms.

PROGRAM PROJECTIONS

It is not anticipated that the program will significantly increase in the foreseeable future as the Civil Engineering Department has completed a growth phase during the past two years. The program is at a plateau phase but greater emphasis may be given to sanitary engineering, laboratory experimental work, mathematical modelling, hydraulic systems, urban hydrology, and urban pollution in subsequent years. It is expected that only one additional faculty member with expertise in mathematical modelling of lakes will be recruited in the next few years.

COURSE DESCRIPTION (SELECTED)

217 Economics of Projects in Environmental and Civil Engineering - Economic theory applied to use and control of project management and evaluation. Case studies from water resource field. (3 s.h.)

218 Planning, Administration, Management and Legal Aspects of Projects in Environmental and Civil Engineering - Administrative concepts of water pollution control and other Civil Engineering Projects at all levels of government. Government planning and construction aid programs for environmental control. (3 s.h.)

240 Hydraulic Engineering - Review of fundamental hydraulics. Hydraulics of flows in closed and open conduits. Hydraulic structures. (3 s.h.)

242 Hydraulic Transport of Solids - Hydraulic transport of solids in pipelines and open channels. Hydraulics of multi-phase flows. Applications in design of slurry pipelines and open channels and sediment transport in natural waters. (3 s.h.)

244 Surface Water Hydrology - Hydrologic cycle as a deterministic and stochastic system; rainfall-runoff relations; hydrograph analysis, frequency analysis and extreme value theory; design applications. (3 s.h.)

245 Groundwater Hydrology - Mechanics of flow through porous media. Darcy's law, potential flow theory, steady and unsteady flow to wells, practical aspects of well design, numerical methods, leaky aquifer theory. (3 s.h.)

250 Sanitary Engineering Biology - The fundamentals of biology and biochemistry are discussed, particularly as applied to natural waters and wastewater treatment systems. (4 s.h.)

252 Water and Wastewater Analysis - Principles and applications of quantitative chemical analyses of water and wastewater. (4 s.h.)

254 Water Pollution of Natural Waters - Natural history of water bodies, characteristics of natural water, ecological principles, sources and effects of pollutants, assimilative capacity, oxygen balance, eutrophication, acid mine drainage, thermal pollution, stream standards, water quality monitoring, basin planning. (3 s.h.)

255 Water and Waste Treatment Plant Design - Step-by-step development of a complete plant design for a hypothetical city. Design will be rational and empirical, not theoretical. Process design, equipment selection, economic evaluation, and plant layout will be emphasized. (3 s.h.)

259 Current Topics in Environmental Resources - Group discussion of selected readings and investigation into events of current environmental interest. (3 s.h.)

265 Advanced Environmental Systems Laboratory - Functional design, simulation, and evaluation of elements of environmental systems. (Var. cr.)

267 Advanced Social and Environmental Systems Analysis - Time series analysis, estimation of recursive systems, the identification problem, estimation of simultaneous equation systems. Environmental application. (3 s.h.)

340 Selected Problems in Water Resources - Applications of theories and principles to various practical problems and current topics in water resources. (3 s.h.)

351 Unit Operations of Water Treatment - Theory of several unit processes and operations as applied to water treatment. (3 s.h.)

356 Solid Waste Disposal - Theory, design and operation of systems for the collection and disposal of solid wastes. Course includes study of composition of municipal garbage and refuse and available collection methods. (3 s.h.)

365 Environmental Assessment - Methodology of technology assessment; environmental impact analysis, environmental indicators and the strategic environmental analyses system; case studies; the 1972-74 SST review. (3 s.h.)

390-391 Sanitary and Environmental Engineering Seminar - Current sanitary and environmental engineering subjects. (1 s.h.)

INSTITUTION: UNIVERSITY OF RHODE ISLAND

PROGRAM: Environmental Engineering

DEPARTMENT: Civil and Environmental Engineering

DEGREE: Bachelor of Science (B.S.)
Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Calvin P. Poon
Professor of Environmental Engineering
Department of Civil and Environmental Engineering
University of Rhode Island
Kingston, Rhode Island 02881

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Civil and Environmental Engineering program offers degrees in environmental engineering at the graduate level and an environmental option in civil engineering at the undergraduate level. Approximately fifteen years ago the graduate curriculum was initiated and the undergraduate option began in 1971.

Emphasis of the program is in the areas of water supply and treatment facilities, municipal and industrial waste treatment, flocculation and coagulation of wastes, pollution of marine sediments, air pollution, solid waste management, and modeling of environmental systems. The program is flexible and allows students to develop programs to meet their own professional goals.

Research facilities available to the program include the Rhode Island Water Resources Center which provides research and training in all phases of water resources.

PROGRAM REQUIREMENTS

Admission at the undergraduate level requires a high school diploma with sixteen units of college preparatory work to include four units in English, four in math, two in physics and chemistry, three in history, social science and/or foreign language, and three additional units.

Requirements for admission to the M.S. program include a bachelor's degree in civil or environmental engineering and the Graduate Record Exam. Applicants with undergraduate degrees in other engineering fields or in math, biology, chemistry, or physics may be admitted with the possible addition of prerequisite courses. The Ph.D. program requires a master's degree in civil or environmental engineering or in a related field and the Graduate Record Exam.

The B.S. degree requires completion of one hundred and twenty-four to one hundred and twenty-seven credits. Although students have the flexibility to design their own programs of study, at least twenty four credits must be taken in approved courses in engineering and other areas appropriate to a program in civil and environmental engineering. The courses must be selected so that the student's total program satisfies the accreditation requirements of the Engineer's Council for Professional Development in basic science, engineering science, and engineering design and synthesis.

The M.S. program has thesis and non-thesis options. Either option requires thirty credit hours of course work, two credits in a graduate seminar, and a minimum of two courses taken outside the department. The non-thesis option requires a comprehensive report. Ph.D. requirements include a qualifying exam, thirty credits of course work beyond the M.S. degree, one foreign language, and a three-course and a two-course minor from outisde the department which may include work at the master's level.

CURRENT FACULTY, STUDENTS, GRADUATES

Program faculty consists of three full-time members, one who teaches full-time and two who teach approximately sixty-five percent of the time and are responsible for research during the remainder. Research funding is currently provided by the National Science Foundation and the U.S. Army. Previously, funding has been available from EPA and Department of the Interior.

There are currntly seven full-time and four part-time students in the graduate programs. Exact numbers of undergraduates are impossible to determine since environmental engineering is an option and depends upon which courses a student may take. Recruitment is done by the Civil and Environmental Engineering Department and consists of contacting other schools and distribution of brochures on the program. Most students come from Rhode Island and surrounding areas such as Massachusetts and Connecticut. The vast majority of graduate students are receiving some form of financial support, primarily research and department assistantships.

An average of ten undergraduates receive the B.S. degree with the environmental option each year. Approximately five M.S. degrees and about one Ph.D. are also awarded every year. Graduates have little trouble finding employment and are placed in employment positions through job referrals from companies and the University placement office. About seventy-five percent of program graduates work in the private sector and the remaining are employed by government agencies.

PROGRAM PROJECTIONS

Program officials anticipate no change or expansion in the program in the foreseeable future.

COURSE DESCRIPTION

(the following is a partial listing of courses)

Undergraduate courses:

374 Environmental Engineering - Systems concerned with urban environmental problems of water supply and treatment, sewerage treatment of municipal and industrial waste waters, stream pollution, air pollution, and disposal of solid waste materials. (3 s.h.)

470 Water Supply and Treatment - Development of surface and ground water supplied, water transporation and distribution systems. Water treatment processes including chemical coagulation and precipitation, water softening, iron and manganese removal, disinfection, corrosion control, and saline water conversion. (3 s.h.)

471 Municipal Waste Water Systems - Development of systems for the collection and conveyance of municipal waste waters. Treatment of waste waters by physical, chemical, and biological systems. Re-use of waste waters. Regional systems development and financing. (3 s.h.)

472 Industrial Air Pollution - Sources and characteristics of pollution, allowable concentrations and control, sampling, diffusion, site selection, and abatement programs. Air resources management programs. (3 s.h.)

473 Analysis of Air Pollutants - Pollutants in the atmosphere. Methods of sampling and interpretation, and analysis of pollutants in gases, vapors, mists, dusts and fumes. (3 s.h.)

478 Solid Waste Disposal and Management - Sources, collection and treatment methods for the removal of solid wastes from the environment. Recovery and re-use of waste materials. Economics of solid wastes and by-products. Interrelation between solid wastes, air and water pollution. (3 s.h.)

495 Civil and Environmental Engineering Systems - Practical civil and environmental engineering projects, broad in scope from the areas of water resources, structures, pollution control and transportation are studied, analyzed, designed and discussed. (3 s.h.)

Graduate courses:

572 Biosystems in Sanitary Engineering - Microorganisms which constitute the biological systems in water pollution, water purification and waste water treatment. (3 s.h.)

588 Groundwater Hydrology - Quantitative methods of groundwater hydrology including determination of aquifer properties and yield. Modeling of groundwater systems for management quantity of water and movement of contaminants. (3 s.h.)

671 Advanced Waste Water Treatment - Latest developments in biological and physiochemical treatment processes. Emphasis on the tertiary treatment of sewage and the ultimate treatment of industrial wastes. (3 s.h.)

672 Water Pollution Control and Treatment of Waste Water - Waste water characteristics, effects and purification in natural water, government control strategies and impacts, cost of control, theory and mathematical concepts of secondary and tertiary treatment process, their limitations and late developments. (3 s.h.)

673 Theory of Water Purification and Treatment - Principles of modern water purification and engineering practices. (3 s.h.)

674 Sanitary Engineering Laboratory - Advanced phases of sewage treatment and purification including sludge digestion, sludge gas analysis, biochemical oxygen demand, conditioning of sludge, activated sludge, sewage trickling filters and chemical precipitation. (3 s.h.)

678 Industrial Waste Water Treatment - Advanced considerations of industrial waste disposal problems of major waste producing industries, including waste producing processes, composition of waste waste treatment methods, and in-plant abatement techniques. (3 s.h.)

INSTITUTION: UTAH STATE UNIVERSITY

PROGRAM: Civil and Environmental Engineering

DEPARTMENT: Civil and Environmental Engineering

DEGREE: Bachelor of Science (B.S.), Master of Science (M.S)
Doctor of Philosophy (Ph.D.) in Engineering

CONTACT: Dr. James H. Reynolds
Assistant Professor
College of Engineering
Utah State University
Logan, Utah 84322
(801) 752-4100 x 7744

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering degree programs have been a major component of the College of Engineering since 1967. Currently, the Bachelor of Science degree is offered through the Department of Civil and Environmental Engineering, and the emphasis, at this level, is on civil engineering.

The Master of Science (M.S.) and the Doctor of Philosophy (Ph.D.) degree programs are administered by the division of environmental engineering. At the graduate level students undertake specialized training which include courses such as hydrology, water quality analysis, water quality management, advanced wastewater treatment processes, and design of water and wastewater systems. These courses are a strong complement to the undergraduate curriculum, especially the water quality, water resources concentration. These programs are accredited by the Engineers Council for Professional Development.

Extensive research activities are conducted by the College of Engineering through the Engineering Experiment Station, the Utah Water Research Laboratory and the departments and division of the college. Graduate students are able to participate in the various areas of research. Undergraduates often find part-time employment with the various research components.

Graduates of these degree programs find immediate employment at whatever level the career path is elected. Although the majority of the graduates are employed in occupations related to water and wastewater pollution control and abatement, there are graduates who enter teaching at the post-secondary level, private consulting/engineering firms, and environmental planning and management jobs.

PROGRAM REQUIREMENTS

The baccalaureate civil and environmental students generally adhere to the typical engineering program during the first two years. During the third year, the student normally completes 11 civil and environmental courses for 36 quarter hours; seven quarter hours in general education and English and six additional engineering credits. The senior year core includes nine quarter hours in general education, and 21 quarter hours in civil and environmental courses. In addition, the student completes 18 quarter hours in specific water quality, water resources, hydraulics, and hydrology courses.

Approximately 20% of the graduates, at the baccalaureate level, elect to continue their education without employment interruption. Those students entering the world of work are considered to be highly employable. They encounter few obstacles to employment in the private and public sectors.

The Master of Science in environmental engineering requires a minimum of 45 quarter hours at the graduate level, including nine hours of research and thesis. Certain core courses include CEE 664, CEE 665, CEE 562 and CEE 666. Strongly recommended are water quality management and solid waste management (CEE 761, 762 and 763). In addition, water quality modeling, industrial wastewater, aquatic microbiology, and chemistry of soil-water systems (CEE 568, CEE 667, BACT 560, SOILS 505) are recommended courses for all environmental engineers. Completion of the master's program usually requires five quarters of full-time study.

Course requirements and research projects are individually designed at the doctoral level. The minimum requirements include, however, at least 90 quarter hours of course work above the master's level. At least two years full-time study above the Master of Science is required for the Ph.D. degree. A comprehensive exam and oral defense of the doctoral thesis is required.

CURRENT FACULTY, STUDENTS, GRADUATES

Current faculty includes seven full-time equivalents (FTE) consist of: 2.47 teaching; 1.95 administration; and 2.56 research. Approximately 5.49 FTE are cost-centered. All seven faculty members have Ph.D.s and have conducted appropriate research in their fields. Those personnel not included as cost-centered are supported by means of engineering extension activities.

Student enrollment at the B.S. level includes approximately 84 seniors. Environmental engineering at the graduate levels totals 38. At the master's level there are 16 male and two female full-time students, olus three part-time students. The doctoral program includes 14 male and three female full-time students.

Approximately 32% of the College of Engineering undergraduate and graduate students are environmental engineering majors. The programs attract career change students at least at the baccalaureate level.

Only 50% of the entering graduate students have undergraduate degrees in engineering. Other student undergraduate degrees are from the areas of chemistry, microbiology, and natural resources. On the average, approximately 10-15 graduate students are admitted each year.

The number of graduates has shown a slight increase on the average over the last three years. Approximately 23 students, annually, earn the Master of Science degree. Approximately 11 students per annum are awarded the Doctor of Philosophy degree.

Approximately 20% of the students receiving the Master's degree elect to pursue a higher degree. This is the same percentage as at the baccalaureate level, as stated above. Of the doctoral students, 65% continue for post-doctoral studies.

PROGRAM PROJECTIONS

Historically these programs have been expanding. While the student enrollment may have stabilized, some growth is projected over the next few years. The programs are regarded as outstanding in the Rocky Mountain area, and although some efforts have been made to effect an approximate 10% reduction in student enrollment, the result indicated slight increase.

Substantial changes in the programs or in the faculty composition are not anticipated.

COURSE DESCRIPTION

Undergraduate courses (selected):

CEE 305 Mechanics of Solids - Stress, strain, and deflection due to flexure and shear. Combined stresses, instability, effect of repeated and dynamic loadings. (3 q.h.)

CEE 308 Structural Design - Fundamental principles and practice of the design of steel, concrete, and timber structural elements. (3 q.h.)

CEE 328 Engineering Materials - Influence of atomic arrangement, bonding, and crystalline structure on the properties of construction materials. The properties, requirements, and uses of engineering materials in modern construction. (3 q.h.)

CEE 343 Water Resources Engineering-Hydrology - The hydrologic cycle, including weather elements and climate, precipitation, evaporation, transpiration, infiltration, groundwater, runnoff, and methods of collection of hydrologic data. (4 q.h.)

CEE 350, 351 Fluid Mechanics - Properties of fluids, principles of hydrostatics, fluid dynamics, principles of similarity, flow of fluids in pipes, measurement of fluid flow. (3 q.h.)

CEE 352 Water Resource Engineering-Hydraulics - Uniform and non-uniform open channel flow; pipe network analyses, pumps and pumping systems; design considerations. (4 q.h.)

CEE 360 Resource Utilization and Environmental Management - Concepts relating the role of engineering in the technological processes affecting our civilization. (3 q.h.)

CEE 363 Environmental Engineering-Aquatic Systems - Development of concepts and principles of chemistry and biology and their application to engineering systems. (3 q.h.)

CEE 364 Environmental Engineering I - Application of physical, chemical, biological, and hydraulic principles to the treatment and distribution of water. (3 q.h.)

CEE 365 Environmental Engineering II - Application of physical, Chemical, biological, and hydraulic principles to the collection and treatment of wastewater. (3 q.h.)

CEE 420 Engineering Economics - Applications of the mathematics of finance to engineering decision making. (3 q.h.)

CEE 425 Legal Aspects of Engineering - Synopsis of the law of contracts. Writing of engineering specifications. Engineering ethics. (3 q.h.)

CEE 430 Soil Mechanics - Elementary physics of soil as applied to engineering problems. Moisture, plasticity, and capillary relationships. Percolation and the design of earth structures and foundations. (3 q.h.)

CEE 493 Independent Study - A laboratory design or a research project on a problem selected by the student. It requires a review of literature, preparation of a proposal which describes the project, and the completion of a design or research and the preparation of a report. (3 q.h.)

ME 502 Mechanical Vibrations - See ME 502. (3 q.h.)

ME 504 Mechanics of Solids - See ME 504. (3 q.h.)

CEE 531 Soils Engineering - Application of engineering soil mechanics and structural theory to the design of foundations, dams, highways, and other engineering problems. (3 q.h.)

CEE 540 Water Project Design - Team solution of water project design problems. (3 q.h.)

CEE 550 Applied Hydraulics - Course for nonengineering students. Fluid statics and dynamics, flow in pipes and open channels, flow measurement, pumps. (4 q.h.)

CEE 551 Hydraulic Transients - Unsteady flow in closed conduits, pipeline surges, water hammer, unsteady channel flow, channel surges, flood waves. (3 q.h.)

CEE 561 Water Quality Analysis - Methods of physical, chemical, and biological analysis of water and wastewater; underlying principles

CEE 561 (cont'd) - and limitations of test methods; statistical significance of data. (4 q.h.)

CEE 562 Chemistry of Aquatic Systems - Emphasis on the chemical processes occuring in a natural environments. Principles of physical chemistry applied to problems involving the composition of natural waters and man's influence on these systems. (3 q.h.)

CEE 565 Design of Municipal Water and Wastewater Systems - (3 q.h.)

CEE 566 Water Systems Analysis and Planning - Practical water resources problems, including quality dimension, examined. (3 q.h.)

CEE 568 Water Quality Modeling for Environmental Management - Theory and application of mathematical models to water quality problems. Review of state-of-the-art models. (3 q.h.)

Graduate courses:

CEE 601 Structural Matrix Analysis - General theory of finite element matrix structural analysis. (3 q.h.)

ME 602 Mechanical Vibrations, Advanced.

CEE 630 Earth and Rock Fill Dams - Design details of earth and rock fill dams, seepage, and stability analysis. (3 q.h.)

CEE 640, 641 642 Hydrologic Methods - Mathematical, statistical, and graphic techniques in hydrology, including linear and nonlinear systems optimization, computer modeling, and parametric simulation; stochastic processes, including frequency analysis and statistical generating techniques. Flood hydrology, including methods of hydrograph analysis, forecasting, routing, and control. Snow hydrology, including accumulation and melt characteristics. (3,3,3 q.h. each)

CEE 643 Groundwater Hydrology - Aquifer properties; storage, movement, recharge, and withdrawal; safe yield, planning, development, and management of groundwater; economic and legal consideration; maintenance of groundwater quality; conjunctive use. (3 q.h.)

CEE 656 Sediment Transport - Channel roughness and design of stable channels. Three lectures, one lab. (4 q.h.)

CEE 664, 665, 666 Water and Wastewater Treatment - Prerequisite: Instructor's consent. (4, 4, 4 q.h. each)

CEE 742 Water Resources Engineering Systems - Relationship of development of water resources to development of other natural resources. Historical and present concepts in water development. (3 q.h.)

CEE 743 Water Resources Engineering Institutions - Current problems and policies on water resource allocation and administration.

CEE 743 (cont'd) - Institutional factors, coordinating mechanisms, and state and federal role in water resource development. (3 q.h.)

CEE 744 Water Resources Engineering Planning - General principles and procedures of water resource planning iwth a regional, multi-purpose context; considerations of project formulation, alternative plans, socio-economic analysis, and financing. (3 q.h.)

CEE 761 Water Quality Management - Natural and man-made characteristics of water quality, water quality requirements for beneficial use and discharge to receiving waters, and elements of technology available for water quality management. (3 q.h.)

CEE 762 Air Quality Management - Classifications of air pollutants and their sources, air quality standards, atmospheric sampling and analysis, technical approaches to control, regulatory measures and selected topics in meteorological and biological effects. (3 q.h.)

CEE 763 Waste Management - Nature and scope of the solid waste disposal problem, the general state of the art, and management solutions based on social, economic, and technical considerations. (3 q.h.)

SECTION V - MASTERS, ENVIRONMENTAL ENGINEER DEGREE, AND DOCTOR OF PHILOSOPHY DEGREE PROGRAMS

- Colorado State University
- Drexel University
- Harvard University
- Iowa State University
- Rutgers University
- Rutgers University
- Stanford university
- Syracuse University
- The Pennsylvania State University
- University of California-Berkeley
- University of Florida
- University of Kansas
- University of Kentucky
- University of Maine-Orono
- University of Missouri-Rolla
- University of North Carolina-Chapel Hill
- University of North Carolina-Chapel Hill
- University of Tennessee
- University of Texas-Austin
- University of Texas-Austin
- University of Wisconsin-Madison
- Vanderbilt University
- Virginia Polytechnic Institute & State University

INSTITUTION: COLORADO STATE UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science (M.S.), Doctor of Philosophy (Ph.D.)
in Civil Engineering

CONTACT: Dr. David W. Hendricks
Department of Civil Engineering
Colorado State University
Fort Collins, Colorado 80521
(303) 491-8273

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering is one of the major programs in the Department of Civil Engineering at Colorado State University. The program began in 1965 as sanitary engineering. In the late 1960s trends shifted in the profession and national concern placed specific demands on engineers to deal with a variety of environmental problems. In 1971, the program was redesignated as environmental engineering.

The program is oriented toward producing professionals, and students acquire a broad understanding of environmental problems as well as sufficient discipline depth. The environmental engineering program provides academic focus through a core of faculty, facilities, courses and research in environmental areas. Students achieve breadth of study through departments and institutes including microbiology, chemistry, economics, sociology, ecological science, the Environmental Resources Center, and the Environmental Engineering Committee of the College of Engineering.

Environmental engineering is normally considered a graduate level program. Students in the bachelor's program of civil engineering, however, may place their emphasis on environmental engineering although there is no formal program at this level. The graduate program, as presently structured, consists of the main areas of water quality and environmental analysis.

The water quality program leads to both the M.S. and Ph.D. degrees. Emphasis is on the physical and biological aspects of sanitary engineering. The program deals with the unit operator and unit processes approach to water purification and wastewater treatment, advanced wastewater treatment, water reuse and desalination. Emphasis is also placed upon the improvement of water quality and pollution abatement. The program also stresses waste management. Courses in air pollution, meteorology and special solid waste management seminars give the student breadth in this area.

Environmental analysis provides an interdisciplinary approach to planning and design of large scale facilities. The program is recommended as complementary to an existing degree program and does not, at present, lead to a separate degree. Students with adequate background are allowed to structure a degree program in this area, however.

PROGRAM REQUIREMENTS

The academic program allows the student a great deal of flexibility in program design. The main concern is that the student receives a strong background in the traditional core and then focuses on a particular area of concern.

Students in the master's program have two options. The M.S. degree may be pursued with or without thesis. Students in the thesis program must complete 30 semester hours plus their thesis. The non-thesis option requires a minimum of 32 semester hours before graduation. All M.S. students must complete physical chemistry, general microbiology, unit operations, unit processes and water and wastewater analysis.

The Ph.D. degree requires 30 semester hours of course work beyond the master's degree. Courses in microbiology of water sewage, air pollution control, instrumental analysis and air quality are required. Research must culminate in the production of a dissertation in environmental engineering.

CURRENT FACULTY, STUDENTS, GRADUATES

The current number of faculty directly involved in the environmental engineering program is five. There are two full-time and three part-time appointments. All faculty members in the program devote about 50% of their time to teaching and 50% to research.

Student enrollment in the master's program is somewhat unstable with the average number of students ranging from six to 12. This year, enrollment is down with only three students in the M.S. program. The Ph.D. program has seen a slight increase in students this year, with a total of three. The average number of graduates per year in the doctoral program is one.

Graduates of the program have no difficulty in finding employment in their field of interest. At present, the employment rate is 100%. Students seeking employment are encouraged by faculty members to enter the private sector. Over 80% of the graduates now are employed by consulting engineering firms. The remaining 20% find employment with private industry.

Student support is limited, and the majority of financial aid is derived from private consulting sub-contracts. Funds are usually available to support four students per year.

PROGRAM PROJECTIONS

The main objective of the program for the next three years, is to stabilize the student enrollment. The faculty hopes to see a slight increase in the graduate student population, from 10 to 20 in environmental engineering. Stronger courses in the areas of waste management, such as solid and hazardous wastes, are also planned. An increase in faculty will be seen in the next year with the addition of one Ph.D. in the area of sanitary engineering.

COURSE DESCRIPTION (Selected)

CE 438 Water Supply and Wastewater Removal - Planning and design of storage and distribution components, water supply systems, and sewerage systems. (4 s.h.)

CE 440 Environmental Health Engineering - Water purification and wastewater treatment and disposal; solid waste management; air pollution control; and environmental radiation.

CE 537 Solid Waste Management - Planning solid waste systems; unit operations; processing technologies; resource recovery; disposal alternatives. (3 s.h.)

CE 538 Aqueous Chemistry - Solution chemistry emphasizing quantitative description of equilibrium systems, especially natural waters. (3 s.h.)

CE 539 Water and Wastewater Analysis - Wet chemical and instrumental methods of analysis. (3 s.h.)

CE 540 Unit Operations of Environmental Engineering - Water and wastewater treatment processes; separations of particulates by gravity, coagulation, filtration, carbon adsorption. (4 s.h.)

CE 541 Unit Processes of Environmental Engineering- Water and wastewater treatment processes; combustion, disinfection, aeration, activated sludge, trickling filters, anaerobic digestion, ponds. (3 s.h.)

CE 542 Principles of Desalination - Reverse osmosis; electrodialysis; freezing; distillation; ion exchange; and brine disposal. (3 s.h.)

CE 543 Industrial Water and Wastewater Treatment - Boiler feed-water treatment; cooling-water treatment; industrial wastewater reduction, recover, reuse, treatment, and disposal. (3 s.h.)

CE 623 Water Quality Hydrology - Effects and dispersion of natural, municipal, industrial, toxic, and other water pollutants on natural and impounded waters. (3 s.h.)

CE 638 Environmental Assessment - Planning principles applied to the problem of accounting for environmental side effects and consequences of civil engineering projects. (2 s.h.)

CE 639/S 639 Technology Assessment and Social Forecasting - Interrelationship between technology and society emphasizing procedures for evaluating impacts and forecasting alternatives. (2 s.h.)

INSTITUTION: DREXEL UNIVERSITY

PROGRAM: Environmental Engineering and Science

DEPARTMENT: Multidisciplinary Institute for Environmental Studies

DEGREE: Master of Science in Environmental Engineering
Master of Science in Environmental Science
Doctor of Philosophy

CONTACT: Dr. P. W. Purdom
Director of Environmental Engineering and Science Program
Institute for Environmental Studies
Drexel University
Philadelphia, Pennsylvania 19104
(215) 895-2265

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Initiated in 1963, the graduate program in Environmental Engineering and Science is offered by the Institute for Environmental Studies. The departments of physical sciences, engineering, and life and social sciences cooperate in this multidisciplinary program. The following areas of concentration are offered: Environmental Health; Environmental Planning and Management, Air Resources, Occupational Health; Water Quality and Resources; Solid Wastes; Environmental Assessment; and Environmental Chemistry. Other tracts of study may be developed where the preceding do not meet the student's needs.

Faculty and students utilize research facilities in various colleges for their work in environmental programs. The program's own laboratories include solid wastes, water and wastewater treatment, toxicology, environmental chemistry, and environmental rooms for the study of human behavior and reaction. Small incinerator studies using air flow equipment contained in a large incinerator room are conducted. An environmental library is located at Drexel's library and students have access to computer based abstract services (plotting facilities) and computer terminals. Much research is conducted in collaboration with government agencies and industries in the field. An example is a re-oxygenation study currently being conducted at a dam site in Georgia by a Drexel professor.

PROGRAM REQUIREMENTS

In order to enter this program a strong background in science and mathematics is necessary and applicants are requested to have at least two terms of college chemistry and differential and integral calculus. Students with this background are welcomed from all engineering fields, physical, life, and the social sciences.

PROGRAM PROJECTIONS

Enrollment has remained stable, although a slight decline has been detected by program officials. Most part-time students are enrolled in water pollution courses. Solid waste courses are now offered every other year. These courses have not been developed as a full-time program. The air pollution specialty may have to be dropped as a specialty area if the number of students enrolled in this area does not increase.

Most faculty additions are expected to result mainly from replacing staff members who have left. Recently, a civil engineer was recruited with an air pollution control engineering background. Two other replacements are foreseen and one, a civil engineer, has a water quality engineering background and the other, a toxicologist, will be recruited by the Biological Sciences Department to teach Biochemistry courses.

Expansion of the program depends on the needs of cities and industry for short course in-service training. If expansion does become necessary it will probably be in the areas of toxic and hazardous substances which are big health problems. Thirty or more students are enrolled in the occupational health specialty area without training grants as they perceive this as an area requiring future trained specialists.

COURSE DESCRIPTION (SELECTED)

F 202 Environmental Chemistry - Principles of physical and organic chemistry applicable to the study and evaluation of environmental conditions, especially the pollution of air, water, and soil. (3 q.h.)

F 208 Fate of Pollutants in the Air and Water Environment - The physical and chemical mechanisms that define the fate of a pollutant are theoretically delineated and applied to model environmental systems. (3 q.h.)

F 209 Advanced Environmental Chemistry - Thermodynamic and kinetic principles and their application to the study of chemical changes and reactions in the water or air environments. (3 q.h.)

F 214 Environmental Physiology - Effects of air pollutants, water pollutants and general environmental factors such as heat, light, sound, stress and activity upon the functions of the human respiratory, nervous, blood and excretory systems. (3 q.h.)

F 221 Environmental Health - Evaluation of environmental hazards, design of environmental controls for the health and well-being of man. (3 q.h.)

F 222 Epidemiology - Principles, purposes and methods of epidemiology; application of methods for the investigation of problems in the field of human diseases, infectious and non-infectious, emphasizing the relationship and equilibrium of host and environmental factors. (3 q.h.)

F 239 Toxicology - Acute and chronic effects of toxic substances and residues. Environmental exposures and controls. (3 q.h.)

F 241 Air Pollution Control Processes - Detailed study of the design and operation of air pollution control processes: settling filtration, inertial separation, scrubbing and precipitation. (3 q.h.)

F 243 Air Pollution Sources - Sources of air pollution will be considered in depth. (3 q.h.)

F 244 Air Resource Management - Component parts of air pollution control programs: air pollution standards, background survey, elements of air pollution control laws, misdemeanor and injunctive surveys, socio-economic surveys, and operation of an air resource management program. (3 q.h.)

F 252 Water Quality Control Laboratory - Analytical procedures used in the assessment of water quality as applied to the analysis of natural waters and to the control of water and waste water treatment processes. (3 q.h.)

F 255 Stream Analysis and Pollution Control - Fundamentals of limnology. (3 q.h.)

F 270 Solid Wastes Systems - An analysis of the public health, economic and political aspects in the operation and design of storage, collection and disposal of solid waste materials. (3 q.h.)

F 279 Environmental Project Analysis - Candidates for the master's degree in Environmental Science, or Environmental Engineering, are required to select an appropriate problem, formulate an approach to its solution, and then test this solution in so far as it is practical. (3 q.h.)

F 291 Research Methods - Introduction to research methods and literature, procedures for the collection and analysis of data; preparation of technical papers. (3 q.h.)

F 298 Thesis - Each student working on a dissertation will file a written report each quarter with his supervisory committee. A copy of this report must be filed with the Program Graduate Student Advisor. (2-12 q.h./term)

INSTITUTION: HARVARD UNIVERSITY

PROGRAM: Environmental Sciences and Engineering

DEPARTMENT: Applied Sciences

DEGREE: Master of Science (S.M.)
Master of Engineering (M.E.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. J. Carrell Morris
Division of Applied Sciences
Pierce Hall
Harvard University
Cambridge, Massachusetts 02138
(617) 495-2855

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental sciences and engineering is primarily a water quality oriented program. It's foundations go back to the sanitary engineering program, which began at Harvard in 1913.

The program is extremely flexible, allowing students to concentrate their studies in fields which correspond to their interests and objectives. A tendency of the program is to specialize in the disciplinary rather than the applied aspect of environmental engineering and science. A large portion of program graduates go on to teaching and research.

Facilities available for program use include environmental biology and chemistry laboratories, a university computing center, the Center for Earth and Planetary Physics, and the Center for Population Studies.

PROGRAM REQUIREMENTS

Program admission requirements are based chiefly on the applicant's undergraduate or previous graduate academic performance and letters of recommendation. The applicant must have an academic record of distinction as well as adequate preparation in his/her field of intended study. The Graduate Record Examination Aptitude and Achievement tests are also required.

The S.M. degree requires the completion of eight graduate courses, in residence, which comprise an integrated program which is approved by the student's faculty and Committee on Higher Degrees advisers. If a student is interested in a particular subject area not offered in the School of Arts and Sciences, he/she may be allowed to cross register in other Harvard graduate schools or at M.I.T. No thesis or language is required and normal completion of the S.M. program takes one year.

An M.E. degree is a professional, advanced degree which does not have the research requirements of the Ph.D. This program requires the completion of one year of course work beyond the S.M. degree or a total of sixteen graduate courses. Included in this may be course work devoted to the completion of a project upon which a written report must be submitted. All courses taken in this program must form a coherent program approved by the Committee on Higher Degrees. No thesis, foreign language, or general examination is required.

The minimum requirement for the Ph.D. is two years of advanced study beyond the undergraduate level. Study must be conducted in one major field in which at least six graduate courses are completed and a minor field in which three graduate courses are required. A dissertation as well as a general exam in the major field of study and a special exam in the minor field are required. There is, however, no foreign language requirement.

CURRENT FACULTY, STUDENTS, GRADUATES

A total of seven faculty members, four full-time and three part-time, divide their time about equally between teaching and research. Several sources of research funding are available, including EPA, the National Science Foundation, the Department of the Navy, the Department of Defense, and the Ford Foundation.

There are currently two students in the Master's program and twenty to thirty in the Ph.D. program, all full-time. A few students are career change, coming from such disciplines as chemistry or biology. No ratio of in-state/out-of-state students is kept and no formal recruiting is done for the program. Only one-third of the applicants are accepted and most come from referral by previous students. Almost all students receive some form of financial assistance, primarily research assistantships. Other forms are university fellowships and National Science Foundation fellowships.

Approximately six students per year graduate from the Ph.D. program and two to three Master's degrees are awarded each year. These numbers remain fairly constant. The number of Master's degrees awarded is higher than the number of students in the program because Ph.D. candidates are also eligible for the Master's and each year, some graduates elect to receive it along with the Ph.D. Virtually all graduates go directly into employment, about three-fourths of them in academic positions and the remainder in consulting firms.

PROGRAM PROJECTIONS

No program expansion or increase in faculty is foreseen in the near future.

COURSE DESCRIPTION

(the following is a partial listing of courses)

Eng 250a Design of Water Resource Systems - Principles of engineering and economic analysis applied to water resources systems. Functional design of comprehensive management systems. Uses techniques of operations research and econometrics to develop methods for planning integrated systems. (no specified semester hours)

Eng 253 Stochastic Processes in Environmental Engineering - Theory and applications of stochastic processes and time series for environmental problems. (no specified semester hours)

Eng 254 Mathematical Programming for Large Systems - Application of optimizing theory to large environmental control systems. (no specified semester hours)

Eng 257 hfr. Seminar: Models for Environmental Systems Planning - Critical evaluation of current systems applications. (no specified semester hours)

Eng 270 Engineering Systems for Environmental Control - Provision of urban water; engineering aspects of collection and disposal of spent water and solid wastes; Data collection and processing for monitoring and control; maintenance and operation of pollution control systems. (no specified semester hours)

Eng 272 Water Quality and Its Management - Nature, sources, and effects of inorganic and organic impurities in natural waters. Water quality standards. (no specified semester hours)

Eng 273 Water Pollution Microbiology - Advanced discussion of the role of microorganisms as both pollutants and purifying agents. (no specified semester hours)

Eng 274 Chemical Models of Natural and Polluted Waters - Chemical aspects of aqueous environmental systems. (no specified semester hours)

Eng 276 Treatment of Water Supplies and Wastewaters - Quality standards for water supplies. Processing of natural water for municipal use. (no specified semester hours)

Eng 280 Environmental Control - Covers design and evaluation of industrial ventialtion systems for the control of toxic

Eng 280 (Cont.) - contaminants released to the workplace through industrial operations and processes and the evaluation and control of noise hazards. (no specified semester hours)

INSTITUTION: IOWA STATE UNIVERSITY

PROGRAM: Sanitary Engineering and Water Resources

DEPARTMENT: Civil Engineering

DEGREE: Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. E. Robert Baumann
Department of Civil Engineering
Iowa State University
Ames, Iowa 50011
(515) 294-4975

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering at Iowa State University concentrates primarily in water related areas of sanitary engineering and is designed first and foremost to give each student a broad understanding of the entire field.

The program began in 1953. Areas of sanitary engineering in which formal programs of study may be pursued include solid/liquid separation, water supply and pollution control, hydrologic and hydraulic design processes, stream water quality, systems analysis, and management of water supply and pollution control systems.

Water Resources is offered under a cooperative arrangement with various departments including Agricultural Engineering, Agronomy, Animal Ecology, Bacteriology, Botany and Plant Pathology, Chemical Engineering and Nuclear Engineering, Civil Engineering, Earth Science, Economics, Family Environment, Food Technology, Forestry and Horticulture.

The three specialities in water resources are water quantity, water quality, water resources economics and institutions.

PROGRAM REQUIREMENTS

Admission to an M.S. program requires an undergraduate 3.0 GPA. PhD. admission requires a 3.5 on Masters work and three letters of recommendations indicating that the applicant has creative ability in the field.

Candidates for sanitary engineering need an undergraduate degree in some field of engineering or are required to complete a program of undergraduate engineering courses without graduate credit as a prerequisite to advanced engineering work. Non-engineering students with science undergraduate majors are admitted if they complete their deficiencies without receiving graduate credit.

All sanitary engineering candidates are required to have completed: mechanics of fluids, hydrology, water and wastewater treatment, design of water supply and sewer systems, design of sanitary engineering system, principles of biology and chemistry including quantitative analysis and organic chemistry.

Each degree is formulated by the student and his/her program of study committee.

Students from engineering or science undergraduate preparation may also enter an Interdisciplinary Program in Water Resources and complete an M.S. or Ph.D.in water resources under the supervision of a professor in the sanitary engineering section of the Department of Civil Engineering.

Each student is required to take two of the following three courses: Water Resources 577, Water Resources 578, Water Resources 579.

DEGREE REQUIREMENTS

Degree	Credits	Thesis	Language	Residence
MS--Sanitary Engineering	45-Q[a]	Yes	No	33 cr.
MS--Water Resources[b]	45-Q[b]	Optional	No	33 cr.
PhD--Sanitary Engineering[c]	108-Q+	Yes	Yes	54 cr.
PhD--Water Resources[b]	108-Q+	Yes	Yes	54 cr.

[a] At least 13-Q must be taken outside the Civil Engineering Department.

[b] Special requirements on number of credits of minor work in water quantity, water quality, and water resources economics and institutions, and for the major in one of these four specialty areas.

[c] At least one minor area of specialization is usually required in addition to the major.

CURRENT FACULTY, STUDENTS, GRADUATES

The faculty devotes half time to teaching and half to research. Presently there are 28 research programs. Monies come from Culligan International, Alcoa, American Water Works Association, Procter and Gamble, Corps of Engineers, Northern Natural Gas, and Lakeside Equipment Company.

Types of student support are research trainees (5), research graduate assistants (27), hourly employment (2), research associate (3).

Enrollment and graduate figures are:

Degree	Program	Enrollment	Graduates
M.S.	Sanitary Engineering	22	9
M.S.	Water Resources	4	2
Ph.D.	Sanitary Engineering	7	0
Ph.D.	Water Resources	4	1

PROGRAM PROJECTIONS

The program is seen as remaining stable with no new growth in number of faculty or students.

ADDITIONAL INFORMATION

A water quality laboratory for physical-chemical-biological analyses is adjunct to the sanitary engineering laboratories, and is operated for the Engineering Research Institute, College of Engineering. Special facilities available for special teaching and research include both the University (iron-removal) and City of Ames (lime-soda softening) water treatment plants, the City water pollution control plant, an agricultural facility for confinement hog and cattle waste handling and treatment (oxidation ditch, anaerobic-aerobic lagoons, and roto-disc systems), and the facilities of the Ames Laboratory of the Atomic Energy Laboratory.

COURSE DESCRIPTION (a partial listing)

Undergraduate courses:

304 Hydrology - Elements of hydrology: precipitation, infiltration, direct runoff, evapo-transpiration, groundwater and streamflow; data collection and analysis, engineering applications. (3 q.h.)

325 Water and Wastewater Treatment - Elements of design and operation of water and wastewater treatment systems, including physical, chemical, and biological treatment methods. (3 q.h.)

328 Sanitary Engineering in Environmental Control - The sanitary engineer's responsibility in protecting public health through environmental control of communicable diseases, air pollution, and solid wastes. Organization, administration, and operation of regulatory agencies. (3 q.h.)

426 Design of Water Supply and Sewer Systems - Engineering aspects of collection, pumping, storage, and distribution of water for public, domestic and industrial uses; and collection of storm, sanitary, and combined waste water. (4 q.h.)

427 Design of Sanitary Engineering Systems - Extension of principles presented in 325 and 426 and applications to integrated water supply or pollution-control design problems; design of specific facilities for sanitary engineering systems. (3 q.h.)

472 Applied Hydraulic Design - Characteristics of flow in natural and constructed channels; hydraulic design of culverts, bridge waterway openings, spillways, stilling basins, hydraulic gates and gated structures, miscellaneous water control structures. (3 q.h.

Graduate courses:

505 Public Works Engineering - The civil engineer's role in the public works field; municipal engineering and public works responsibilities in planning, financing, design, construction, operation, and maintenance of public facilities. (3 q.h.)

520 Water and Wastewater Analysis - Review of the principles of gravimetric, volumetric, and colorimetric methods of analysis. Application of these principles to the laboratory analysis of water and wastewater samples. (3-6 q.h.)

522 Water Pollution Control Plant Design - Investigation and planning activities used to evaluate need for water pollution control facilities and design of such facilities. (3 q.h.)

523 Water Treatment Plant Design - Investigation and planning activities used to evaluate adequacy of existing municipal water supply and treatment facilities. Design of municipal water treatment facilities. (3 q.h.)

524 Solid Waste Collection and Disposal - Planning, design, and operation of solid waste collection and disposal facilities, economics of solid waste collection and hauling, soil and geological considerations, site location and layout, recovery and recycle systems. (3 q.h.)

525 Advanced Treatment of Water and Wastewater - Physical-chemical processes in water and waste treatment. (3 q.h.)

528 Fundamentals of Biological Waste Treatment - Relationship of the fundamentals of biological growth to the design and operation of biological waste-treatment systems. Characterization of wastes relative to their treatability and the selection of appropriate processes for their treatment. (3 q.h.)

574 Multiple Use of Water Resources - Social, economic, and technical phases of governmental participation in public works programs in the field of water resources. Study of multipurpose uses in water resources project planning. (3-6 q.h.)

622 Advanced Topics in Water Pollution Control - Study of advanced concepts in water pollution control. Analysis and application of current developments to pollution control methods. (3-6 q.h.)

623 Advanced Topics in Water Treatment _ Study of advanced concepts in water treatment. Analysis and application of current developments to water treatment methods. (3-6 q.h.)

671 Advanced Topics in Water Resources Engineering - Study of advanced concepts and experimental techniques used in solving water resources engineering problems. Application of simulation methods, mathematical models and advanced research methods in areas of hydrology, hydraulics of water control facilities, and water-resources development. (3 q.h.)

577 Water Resources I - Introduction to water resources planning. Hydrology, including source, distribution and measurement of water; water management categories and beneficial use groups; water requirements, hydraulics and water control facilities. Administered by Civil Engineering. Cooperative with Agricultural Engineering, Agronomy, and Earth Science. (3 q.h.)

578 Water Resources II - Water resources planning. The role of quality in water resources: physical, chemical, and biological aspects of water and waste water. Administered by Civil Engineering. Cooperative with Animal Ecology, Botany and Plant Pathology, and Food Technology. (3 q.h.)

579 Water Resources III - Water resources planning. Legal, government, socioeconomic, administrative, and planning aspects of water resources. Administered by Economics. (3 q.h.)

Agricultural Engineering: 424 Hydraulic Design of Soil and Water Control Facilities - Application of open-channel flow principles to the design of irrigation, drainage, and erosion control facilities. Hydraulics of conduits, and stilling basins. Hydraulics of pumps. Spatially varied flow. Flow through porous media. (4 q.h.)

Food Technology: 414 Food, Milk and Water Sanitation - Control of biological, chemical, and physical environments in maintaining proper sanitation and safety of foods and water. Regulations governing sanitation. (3-5 q.h.)

Chemical Engineering: 353 Energy Transport Operations - Consideration of thermal energy transfer problems that occur in the process industry. Principles developed in 352 are extended to conduction and convection of heat. Design of heat transfer equipment is a major topic. Radiant heat transfer is also covered. (4 q.h.)

INSTITUTION: RUTGERS - STATE UNIVERSITY OF NEW JERSEY

PROGRAM: Environmental and Water Resources Engineering

DEPARTMENT: Civil and Environmental Engineering

DEGREE: Master of Science (M.S.); Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Marvin Leroy Granstrom
Civil and Environmental Engineering Dept.
B245 Engineering Building, Busch Campus
Rutgers - State University of New Jersey
New Brunswick, New Jersey 08903
(201) 932-3682

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental and water resources engineering is a large program within the Department of Civil and Environmental Engineering at Rutgers. Two options are available: sanitary engineering and water resources engineering. Water and wastewater treatment, hydrology, and water resource systems are several fields of specialization offered to students by the department. Research is currently being conducted in water quality analyses and stream sanitation. Graduates have a wide range of professional engineering and teaching employment opportunities available to them. Positions are often obtained with consulting engineering firms, in both federal and state agencies and in municipalities.

Students are also provided with opportunities to arrange joint programs with related departments such as computer, science, economics, environmental science, statistics, and urban planning. Environmental engineering students have access for experimental research to well-equipped laboratories totalling about 20,000 square feet in area. Computer facilities available include an IBM 1130 system located in the engineering building and an IBM 370-158 system in the university computer center. Laboratory facilities available include a water resources laboratory, a chemical engineering laboratory and an environmental science laboratory.

The Department of Civil and Environmental Engineering is currently developing a new curriculum for the class of 1980 as an undergraduate option with emphasis on environmental engineering.

PROGRAM REQUIREMENTS

In order to enter the graduate program a good undergraduate record is required and non-engineering majors may be admitted but must first complete undergraduate Civil Engineering requirements. The minimum requirement for the master's degree is 30 graduate credits and the degree may or may not be completed by electing to complete a 6 credit thesis. Up to 12 credits of courses completed at other educational institutions may be accepted as transfer credit. Master's candidates who do not write a thesis must demonstrate their ability to write an expository or critical essay as a required part of one of their required courses. The doctorate requires 48 credits of course work and proficiency in one foreign language. Ph.D. candidates usually register for two consecutive terms as full-time students in residence. No more than 24 transfer credits may be accepted and 24 credits of thesis research are required in addition to the 48 credits of course work and proficiency in one foreign language. Ph.D. candidates usually register for two consecutive terms as full-time students in residence. No more than 24 transfer credits may be accepted and 24 credits of thesis research are required in addition to the 48 credits of course work.

Faculty and graduate students are exposed to the research activities of the Department during the Departmental Seminars. Each student conducting thesis research is expected to make a presentation of his work at the Departmental Seminars prior to completing the degree program. Graduate research assistantships and teaching assistantships are available to graduate students in the program. One faculty research and two graduate stipends are available to students. The activities of the Water Resources Institute are part of the Water Resource program at Rutgers. Funding sources for research activities include: the New Jersey Department of Environmental Protection, the Pharmaceutical Industry, the National Science Foundation, and the Army Corps of Engineers.

CURRENT FACULTY,STUDENTS, GRADUATES

Five full time faculty members are involved in teaching the Department's environmental engineering courses. A total of 36 students are enrolled in the Environmental and Water Resources Engineering program. Fifteen students are full time and 21 are part time (4 female). Approximately five student annually complete the master's degree program and one to two receive Ph.D.s on the average. Enrollment in the program is steadily increasing. For many students, completion of the master's program is their terminal point although several have referred for additional study after receiving the master's degree.

Virtually all graduates of the Environmental and Water Resources Engineering program obtain employment directly related to their field. Recent trends indicate that two-thirds obtain positions in the private sector and one-third find government jobs. The university assists students in finding employment through a graduate placement office although inquiries from employers to the Department are also accepted for referral to students.

PROGRAM PROJECTIONS

The Water Resources Program is still growing within the Department and additional faculty and research projects and traineeships are needed. Program officials feel that funding students through research projects enable students to obtain practical research experience and are better than training grants. Because of the Department's broad areas of specialization, no new degree programs are to be developed in this area. Sufficient emphasis is placed on a side area at the present time. One additional environmental engineer with a doctorate in the Water Resources area will be recruited during the fall of 1978.

COURSE DESCRIPTION

(the following is a partial listing of courses offered)

Graduate courses 16-180:

501 Analytical Methods in Civil Engineering - Application of mathematical and statistical methods to the analysis and design of civil and environmental engineering systems. (3 s.h.)

561 Advanced Water Supply and Sewerage - Development of sources of water supply; information analysis, and other topics. (4 s.h.)

562 Design of Water and Wastewater Treatment - Functional study of plant loadings in relation to degree of treatment desired. (4 s.h.)

564 Unit Processes in Environmental Engineering - Theory and laboratory experiments of demonstrating the design requirements associated with unit processes in water and sewage treatment. (3 s.h.)

565 Advanced Public Health Engineering - Engineering criteria for evaluating the adequacy of bathing places, hospitals, and housing; control of insects and rodents; effects of air pollutants on human, animal, and plant tissue; methods of measuring levels of pollutants. (3 s.h.)

567 Analysis of Receiving Water Quality - Mathematical modeling of water quality in streams and estuaries. (3 s.h.)

603 Civil and Environmental Systems Engineering - Introduction to the concepts and methodology of a comprehensive and integrated approach to solving complex problems, with the emphasis on case histories to illustrate methodology. (3 s.h.)

611, 612 Advanced Topics in Environmental Engineering - Selected readings in specialized fields of environmental engineering with weekly conferences. Critical review of the literature to be written. (BA)

INSTITUTION: RUTGERS - STATE UNIVERSITY OF NEW JERSEY

PROGRAM: Environmental Science

DEPARTMENT: Environmental Science

DEGREE: Master of Science (M.S.); Doctor of Philosophy (Ph.D.)

CONTACT: Professor A. Joel Kaplovsky
Director of Graduate Programs in Environmental Science
401 Georges Road Laboratories, Cook Campus
Rutgers - State University of New Jersey
New Brunswick, New Jersey 08903
(201) 932-9571

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Environmental Science at Rutgers has long-standing multidisciplinary graduate teaching and research programs since inception in 1920. This problem-oriented program deals primarily with technological solutions to the contamination of our environment from particulate matter, gases, vapors, liquids, and undesirable organisms. Emphasis is placed on the application of the physical, chemical, and biological sciences toward this end. The following areas of specialization are offered: air resources; aquatic biology; aquatic chemistry; chemistry and physics of aerosol and hydrosol systems; environmental chemistry; environmental microbiology; water and wastewater treatment (wastewater is largest area of emphasis); and water resources.

The Environmental Science Program at Rutgers is the oldest of its kind in the United States, and deals with chemical and biological application to the solution of environmental problems. A specialized research group, Rutgers graduates from the Environmental Science Department are qualified for positions in the environmental field where expertise is needed for solutions of problems in which the air, water, solids, and pollution interact. Trained as multidisciplinary scientists, graduates may obtain positions as researchers and as high school and college instructors. They may also find positions within private industry working on waste problems as either industry employers or as consultants. Positions within government may be found in administration, enforcement, research, inspection, and control. Positions for the program's graduates exist at treatment facilities in the capacity of supervisor, director, analyst, technician, and operator.

The department's Environmental Science Laboratory is staffed with bench-oriented, problem-solving scientists in the pollution field.

Facilities are available for the solution of problems ranging from the most simple and practical to those requiring sophisticated analytical capabilities.

Seminars and a large non-degree short course program are conducted by Departmental faculty. Forty percent of the short course teaching load is in the areas of air, wastewater, water supply, and solid wastes. An environmental training center has been developed and one short course consists of seven days a week for air, wastewater, solid wastes and water supply training.

PROGRAM REQUIREMENTS

In order to enter the Environmental Science Program, prospective students must have a strong science-based background including chemistry, physics, biology, mathematics. No students without chemistry background will be accepted into this program. Verbal and aptitude scores from the Graduate Record Examination are required and students must have a grade point average of 2.5 on a one point (high) scale.

In order to obtain the Master of Science degree, 30 credits of required course work (the research M.S. requires 24 credits plus a 6 credit thesis), which represents 50 percent of the selected program of study, must be fulfilled. Research is required to be in the major field of study, and is a twelve month program which requires an advisor. A candidate for the Doctor of Philosophy degree must normally spend not less than one academic year or two consecutive terms, excluding the summer session, as a full-time student in residence. A foreign language requirement for the doctorate is stipulated, and can be fultilled either by examination or by course work (without credit), as approved by the program faculty. Forty-eight hours of course work plus twenty-four hours of research are required for fulfillment of the doctorate.

Research funding is available from the U.S. EPA, the National Science Foundation, the National Institute of Health, the Army Corps of Engineers, and the Department of Energy. The New Jersey Department of Environmental Protection and private industry also fund research concerning waste problems associated with air, water and solids pollution.

A variety of financial aid is available to graduate students and include research contracts, training contracts, industrial fellowships, teaching assistantships, coadjuncts and loans. The Danforth, Woodrow Wilson and Ford foundations offer fellowship programs for graduate students. The National Science Foundation offers graduate fellowships for beginning graduate students. Various publicity and privately sponsored fellowships include stipends ranging from $2,000 to over $5,000 a year and usually cover remission of normal tuition charges, including six summer credits. Teaching and graduate assistantships provide salaries beginning at about $3,969 a year with remission of tuition charges for both the fall and spring terms, plus an additional remission allowance (6 credits) for optional summer study. Assistants are usually required to spend up to fifteen hours per week on their jobs, whether in teaching or research.

CURRENT FACULTY, STUDENTS, GRADUATES

Twenty faculty members contribute to the teaching and research conducted by the Environmental Science Department. Only twelve faculty are involved in full-time teaching activities and fourteen staff teach the Department's courses. Fourteen staff members are involved in research activities.

There are currently 130 students enrolled in the Environmental Science Program and 70 are full-time students. Ninety of the students are male and forty are female (there are no female part-time students). Officials estimate that approximately 40 students annually receive degrees, on the average. Enrollment appears to be steadily increasing in the Environmental Science Department over the past several years.

All those graduating from the Department find employment directly related to their training. Approximately 35 percent of recent graduates find private sector industrial and consulting positions. Another fifteen percent obtain teaching positions within academia and the remaining 50 percent find public sector jobs. Many employers call the Department seeking to employ graduates from the program and this is considered by program officials to be an excellent method of finding employment.

PROGRAM PROJECTIONS

Because of recent rising enrollment trends additional faculty in the chemical and toxicity specialty areas may be recruited within the next five to ten years. Expansion of staff often takes a great deal of time because of the requirement of justifying growth. Program officials find that because of the complexities and work to be performed in this field, the present staff could be easily doubled in size.

The Environmental Science staff has considered developing Master's degree programs in environmental health and occupational health (industrial hygiene). Because the Rutgers program currently is stronger in the pollution sciences than others, wastewater aspects relating to health problems would be emphasized. Recent research has indicated that environmental and occupational health fields have been largely overlooked. Fields such as toxicology and epidemiology are needed to study the effects of low level pollution that is concentrated in the environment because they impact on man. Rutgers is uniquely situated to study such effects because eleven percent of the chemical industry in the nation is located in New Jersey. There is an unlimited potential for expansion in both teaching and research in the chemical and toxicity fields. To adequately begin research in this area, the Rutgers program would have to double its present staff and all present programs should be expanded in a sophisticated direction.

COURSE DESCRIPTION

(the following is a partial listing of courses offered)

Graduate courses 16:375:

501 Waste Treatment I: Sewage Treatment - Physical, chemical and biochemical processes utilized to treat municipal wastewaters. (3 s.h.)

502 Stream Sanitation - Principles of biological stabilization of pollution materials in streams; factors influencing atmosphere reaeration; changes in biological populations in polluted waters. (3 s.h.)

503 Analytical Techniques in Environmental Chemistry - Theory and techniques of analytical procedures applicable to research in environmental science. (3 s.h.)

504 Waste Treatment II: Water Treatment - Chemical, physical, and biological factors affecting development of water supplies; water quality; municipal and industrial water treatment processes. (3 s.h.)

508 Application of Principles to Treatment Problems - Application of fundamental principles concerned in water purification and liquid and waste treatment processes to design and operation problems. (3 s.h.)

510 Pollution Microbiology - Bacteria as indicators of sanitary conditions; liquid and solid waste treatment processes. (3 s.h.)

517, 518 Principles of Environmental Science - Principles and interaction associated with air environment, water environment, and environmental health. (3 s.h. each semester)

524 Source Control of Atmospheric Pollution - Principles, operation, performance, and application of methods and devices to control aerosol and gaseous emissions. (2 s.h.)

525 Principles of Solid Waste Management and Treatment - Solid waste problems in the municipal, industrial, and agricultural areas. (3 s.h.)

526 Limnology of Urban and Suburban Waters - Study of waters stressed by population, development, wastes. (3 s.h.)

541   Environmental Models for Public Decision Making - The development and applications of environmental models discussed in terms of their ability to simulate and predict the workings of environmental systems. (3 s.h.)

791,792   Environmental Science Research - Research in water pollution, water and wastewater treatment, air pollution, and aquatic microbiology. (BA)

INSTITUTION: STANFORD UNIVERSITY

PROGRAM: Environmental and Water Studies

DEPARTMENT: Civil Engineering

DEGREE: Master of Science (M.S.), Doctor of Philosophy (Ph.D.) in Civil Engineering

CONTACT: Dr. James O. Leckie
Associate Professor
Civil Engineering
Stanford University
Palo Alto, California 94305
(415) 497-2300

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

At Stanford University, the environmental and water studies programs are administered by the Department of Civil Engineering. Instituted in 1961 as sanitary engineering, the programs have undergone several changes since inception.

The major focus of these degree programs is on the area of water quality and water pollution control and abatement. The student may choose additional course work in noise pollution, air pollution, environmental planning and assessment, as well as environmental problems associated with power generation. The program is quite flexible, in order to encourage the students to develop interfacing areas of study as they relate to the water resources major concern. The development of individualized programs of study allows students to pursue differing career objectives. At the same time, the wide variety of student background interests are addressed.

Extensive research opportunities are available at Stanford. The College of Engineering maintains a number of laboratories for student and faculty research and instruction. Among these laboratories are: water quality, environmental engineering, fluid mechanics, structural engineering and, soil mechanics. Stanford University is endowed with outstanding supporting facilities which serve only to enhance the degree of excellence which is synonymous with the institutions reputation. Stanford has succeeded in strengthening the graduate program offerings to the point that today, the Stanford graduate engineering programs are ranked third nationally according to the American Council on Education.

PROGRAM REQUIREMENTS

The Department of Civil Engineering also offers the baccalaureate degree. The faculty of the School of Engineering, however, are of the opinion that at least one year of graduate study is essential for professional practice in the areas of civil engineering.

Students wishing to pursue advanced degrees in civil engineering at Stanford, must make application to the Office of Graduate Admission. Upon completion of a given degree, the student must reapply in order to be considered for candidacy in another degree program.

Financial aid is available for graduate students. Fellowships, as well as scholarships, are available in amounts ranging from $500 to $6,875. Teaching assistantships, which are normally awarded only to doctoral students, are available through the Department. Financial stipends may be granted for as much as one-third time for teaching aides participating in these endeavors during the academic year.

Usually a minimum of 45 quarter hours of course work, 25 of which are at the graduate level, are required for the M.S. degree from the School of Engineering. A thesis is not required by the School of Engineering. Normally, the superior student is able to complete the requirements within two academic years (six quarters), provided there are no deficiencies in the undergraduate preparation.

The environmental engineering requirements include the following: at least 18 quarter hours from CE 172, 174, 270, 271 A,B,C, 273, 273 A, 274, 274 A, 275 A,B, 276 A, 276 B, 276 C; at least 15 quarter hours from environmental biology and chemistry, fluid-related courses and planning and analysis; seminars CE 269 and CE 279; and, selected electives.

A student may alter his major area of study and concentrate on water resources or environmental planning. The requirements in this area would include: CE 220, 221 and 222; eight or more quarter hours in restricted electives; at least 12 quarter hours in a technical specialty, either water resources planning (CE 239, 261, 263, 264, 266, 267, 268, 270, 271 A, 271 B, or Geol 230), or environmental planning (CE 170, 172, 173, 174, 175, 228, 229, 261, 270, 272, 276 B, 279, or Law 275); and, CE 269.

Another area of concentration, hydraulics, hydrology, hydromechanics or water resources, includes the following requirements for the M.S. degree: core courses required (CE 203, 261, 264, 269, 270 and IE 229); at least two courses of CE 263, 266 or Geol 230; at least three courses from the areas of hydraulics, hydrology, hydromechanics, or water resources; and, free electives.

The doctoral degree is open to a select and limited number of students. Requirements are tailored to the individual candidate. Ordinarily, however, this degree requires at least three years of course work, research and dissertation.

CURRENT FACULTY, STUDENTS, GRADUATES

The faculty currently involved in the environmental engineering graduate programs includes four full-time teaching members and two full-time plus four part-time research personnel. Four of these faculty members are cost-centered.

Enrollment in these graduate programs overall total 130 full-time students of which 110 are male and 20 are female. There are no part-time students presently in these programs.

Illustrated below, are the current students allocated to the various programs. The co-terminal students indicated below are undergraduate students who are on an accelerated program of study in order to accomplish the baccalaureate and the master's work simultaneously. The engineering degree students (indicated just below the doctoral students) are involved in a level of study which is above the master's level but below the doctoral level.

		Students	
Program	male	female	total
Ph.D.	32	1	33
Engineering Degree	11	0	11
Master of Science	53	9	62
Co-Terminal	14	10	24
Total	110	20	130

Graduates of these programs have averaged approximately 38 annually. Of the total, approximately 35 students per annum receive the Master of Science degree, while three students per year are awarded the Doctor of Philosophy degree.

Usually, three or four graduates at the master's level, elect to pursue the doctoral degree. A majority of these continuing students, choose California Institute of Technology, Harvard or the University of Washington.

Those graduates, at both levels, who choose a career path gain employment in the private sector (approximately 60%), in the public sector (approximately 25%), and in teaching or environmental research positions.

PROGRAM PROJECTIONS

Long range plans on the part of the faculty include expansion of the hydrology concentration. Some growth in all areas may be anticipated. However, significant faculty, student and program changes are not anticipated in the near future.

COURSE DESCRIPTION

Selected courses, Undergratuate and Graduate:

Me En 137 Air Pollution - Sources and effects of urban air pollution. Photochemical smog. Chemistry and fluid mechanics of pollutants. Pollution control; devices and legislation. (3 q.h.)

Me En 138 Noise Pollution - An interdisciplinary survey of noise pollution. Physical description of sound; human perception and response; technology of noise control; legal and economic aspects of noise abatement. (3 q.h.)

Me En 139 Environmental Measurements - The course will consist of laboratory experiments involving measurement techniques for determining environmental quality and pollutant concentrations. (3 q.h.)

Ci En 160 Water-Resources Engineering - Hydrologic measurements, runoff relations, groundwater, water law, reservoir design, frequency analysis, hydraulic structures, planning of water-resources projects. (4 q.h.)

Ci En 170 Man and His Environment - An introduction to the causes, effects, and methods of controlling environmental degradation. (3 q.h.)

Ei En 171 Environmental Planning - Environmental policies and programs with emphasis on the implementation of the National Environmental Policy Act of 1969 and federal legislation controlling air and water pollution. (3 q.h.)

Me En 180 Energy and Society - (Same as Human Biology 140) A unified analysis of the effects on man's environment of the production, distribution and consumption of energy. (3 q.h.)

Ci En 229 Seminar in Social/Psychological Impact Assessment in Planning - Survey of the social and psychological effects of the built environment. (2 q.h.)

Ci En 266 Engineering Hydrology - The hydrologic cycle; runoff relations, unit hydrographs, flood routing, probability in hydrology; hydrologic simulation, stochastic methods in hydrology. (4 q.h.)

Ci En 267 Advanced Hydrology - Application of hydrologic simulation and stochastic methods in hydrology. (4 q.h.)

Ci En 268 Water Resources Development - The planning and design of physical facilities and other measures for the control and utilization of water. (4 q.h.)

Ci En 269 Water Studies Seminar - Discussions by faculty and students on study and Stanford research of water problems. All students in water studies are expected to attend. (0 q.h.)

Ci En 270 Water Quality in Water Resource Development - Effects of organic, nutrient, and thermal pollution on the ecology and chemical quality of streams, lakes, reservoirs, and estuaries. (3 q.h.)

Ci En 271A Water Quality Control I - Unit operations and processes for control of water quality. (3 q.h.)

Ci En 271B Water Quality Control II - Chemical and biological unit processes for the treatment of municipal and industrial wastes. (3 q.h.)

Ci En 203 Statistical Models in Civil Engineering - Applications of probability and statistical analysis to civil engineering. (4 q.h.)

Ci En 206 Stochastic Processes and Decision Statistics for Civil Engineers - Description of stochastic processes; transportation models; hydrologic models; structural dynamics models; harmonic analysis of stochastic processes; application of Markov chain models to civil engineering problems. (4 q.h.)

Ci En 216 Mechanical Properties of Materials - Elastic behavior, strength, and volume stability of structural materials and composites. (3 q.h.)

Ci En 220 Seminar in Infrastructure Planning and Management - Discussion by faculty and students on various aspects of infrastructure planning and management. (1 q.h.)

Ci En 221 Planning and Management Methods I - Introduction to planning theory with emphasis on the alternative roles of the civil engineer/planner. (3 q.h.)

Ci En 222 Planning and Management Methods II - The logic of social inquiry in resolving planning and management problems. (3 q.h.)

Ci En 223 Seminar in Public Systems Evaluation - The role of policy, program, and project evaluation in the planning and management of public systems. (2 q.h.)

Ci En 271C Water Quality Control III - Analysis of advanced or specialized wastewater treatment flowsheets, emphasizing industrial problems, and advanced treatment of municipal waste. (2-3 q.h.)

Ci En 272 Environmental Biology - Discussions on some basic ecological principles and selected topics in aquatic biology including current problems in water pollution, marine biology, limnology, microbial ecology. (3 q.h.)

Ci En 273 Water Chemistry - A systematic presentation of chemical principles and application of those principles to the analysis and solution of problems in aqueous geochemistry. (3 q.h.)

Ci En 273A Water Chemistry Laboratory - Laboratory application of techniques for the analysis of natural waters and wastewaters. (3 q.h.)

Ci En 274 Water Microbiology - Fundamental aspects of microbiology and biochemistry as related to environmental pollution and water quality control processes. (2 q.h.)

Ci En 274A Water Microbiology Laboratory - Experimental approach to understanding fundamentals of microbiology. (1-2 q.h.)

Ci En 275A Water Quality Control Processes I - Laboratory and pilot plant studies of physical and chemical processes for the treatment of water and wastewaters. (3 q.h.)

Ci En 275B Water Quality Control Processes II - Laboratory and pilot plant studies of biological processes for the treatment of water and wastewaters. (3 q.h.)

Ci En 276A Nuclear Methods in Environmental Engineering - The use of nuclear technology in the study and control of environmental processes. (3 q.h.)

Ci En 276B Environmental Impact of Power Generation - Analysis of the environmental impact of power production from commercial energy resources. (3 q.h.)

Ci En 276C Environmental Radioactivity - The biological importance of environmental radiation and the radiation protection standards. (3 q.h.)

Ci En 279 Environmental Engineering Seminar - Discussions on all aspects of environmental engineering. (1 q.h.)

INSTITUTION: SYRACUSE UNIVERSITY

PROGRAM: Sanitary Engineering, Sanitary Science, Civil Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science in Sanitary Engineering (M.S.)
Master of Science in Sanitary Science (M.S.)
Doctor of Philosophy in Sanitary Science (Ph.D.)

CONTACT: Dr. James A. Luker
Dean, College of Engineering
Syracuse University
Syracuse, New York 13210
(315) 423-4341

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The programs in sanitary engineering and sanitary science are designed to provide students with a background in civil engineering, while emphasizing the environmental areas of water and wastewater.

Sanitary engineering, as a program of study, was initiated in the 1950s and was followed by the adoption of a sanitary science program in the mid-1960s. This program prepares students for supervisory positions in the design of treatment facilities and environmental field studies. A sanitary engineering laboratory is available as a supporting facility for the program.

PROGRAM REQUIREMENTS

Requirements for admission to the M.S. programs generally include an acceptable undergraduate degree with a cumulative average of 3.0/4 and the Graduate Record Exam. Admission to the Ph.D. program requires an acceptable M.S. degree with a cumulative average of 3.35/4 in graduate work. Acceptable degrees are normally in an engineering discipline but in the case of the sanitary science programs, they may also be in a physical or natural science.

The M.S. degree programs are offered as thirty credit hour programs with a thesis or thirty-six credit hours without thesis. A minimum of twelve credit hours are required in civil engineering, along with a non-credit civil engineering seminar, and twelve hours of approved electives for the programs with thesis, and twenty-four hours of approved electives without thesis. A minor of at least six credit hours outside the civil engineering department is recommended.

For the Ph.D., sixty credit hours beyond the M.S. degree are required, with about thirty credit hours in course work and the remainder in the dissertation. Candidates must also demonstrate proficiency in two of the following: statistics, Russian, German, French, and Spanish.

CURRENT FACULTY, STUDENTS, GRADUATES

There are currently thirteen faculty members involved in the program, ten full-time and three part-time. The part-time members only teach in the program, while the full-time members spend about seventy to seventy-five percent of their time teaching and the remainder in research. Research funding is available from a number of sources including the National Science Foundation, EPA, the National Institutes of Health, the New York Department of Environmental Conservation, the New York Health Department and a small number of equipment manufacturers.

Presently, the program has fifteen full-time and nine part-time students participating, with several of them in the career change category. It is estimated that about fifteen percent of the students are in-state residents while the reaminder come from all over the country. The department does not recruit students on its own but relies on the University's recruitment program. Currently, students are receiving financial assistance through teaching assistantships, research assistantships, and fellowships.

Approximately ten students per year receive the M.S. degrees. This figure fluctuates widely because of the relatively small number of students in the program. Only an average of one Ph.D. per year is awarded. Most graduates go directly into employment in private industry or consulting firms. A small number find jobs with government agencies or academic institutions or go on to further education. Graduate placement is normally accomplished through faculty contacts and recruitment by industry.

PROGRAM PROJECTIONS

No expansion in program activities or in faculty is anticipated at present.

ADDITIONAL INFORMATION

Program officials conduct certification courses for state environmental and health department personnel in water and wastewater treatment plant operation. Approximately twenty employees per year participate in these courses.

COURSE DESCRIPTION

(the following is a partial listing of courses)

CIE 558 Solid Wastes: Collection and Disposal - Composition of refuse; quantities produced by individuals and industries; collection equipment, methods and associated costs, and other topics. (3 s.h.)

CIE 561 Air Resources I - Occurrence, nature and properties, major sources and quantities of contaminants; ambient air concentration levels, community distribution patterns and control of air pollution. (3 s.h.)

CIE 655 Industrial Wastes Treatment - Theories relating to unit operation methods of wastewater treatment. Application of theories and incorporation of environmental factors in selection of ultimate disposal systems. (3 s.h.)

CIE 659 Advanced Hydrology - The development of advanced theories of hydrologic action including precipitation frequencies, precipitation-runoff relations, magnitude and frequency of maxima and minima, and the interpretation and application of these theories. (3 s.h.)

CIE 660 Civil Engineering Seminar - Research report presentations by students and visiting specialists in civil engineering and associated sicences and professions. This course may be repeated and is required each semester of all M.C.E. candidates. (0 s.h.)

CIE 751 Advanced Water Resources Engineering - Analysis, design, and evaluation of water supply systems. Emphasis on quality and quantity maximization. (3 s.h.)

CIE 752 Advanced Sanitary Design - Theories of analytical design of wastewater plant systems. Evaluation of existing plant efficiencies. Emphasis on theory and design of modern systems. (3 s.h.)

CIE 753 Stream Sanitation - Comprehensive analysis of the biological, chemical and physical phenomena governing the action of wastes and the reaction of water-courses. (3 s.h.)

CIE 754 Sanitary Engineering Practice - Experimental and analytical studies of specific problems pertinent to industry, consulting engineering offices and governmental agencies. Emphasis on integration of a technical solution into the social environment. (3 s.h.)

CIE 764 Industrial Hygiene Engineering and Radiological Health - Environmental hazards to human health. Toxic properties of industrial dusts, gaseous contaminants and ionizing radiations. Theories and principles of maximum permissible doses. Control techniques. (3 s.h.)

CIE 765 Planning, Organization and Administration in Air Pollution Control - Planning of source emission studies and aeromatric surveys. Statistical treatment of data. Criteria and standards of contaminant emission and air quality. Administrative functions of air pollution control organizations. Air resource management. (3 s.h.)

CIE 766 Biological and Health Effects of Air Pollutants - Effects of air pollution on plants, animals and humans. Economic and social aspects of the polluted environment. Case history studies; epidemiological studies; evaluation of air pollution in pulmonary diseases and lung cancer. (3 s.h.)

INSTITUTION: PENNSYLVANIA STATE UNIVERSITY

PROGRAM: Minerals Processing

DEPARTMENT: Material Sciences

DEGREE: Master of Science; Ph.D.

CONTACT: Dr. Leonard G. Austin
Section Chairman of Minerals Processing Section
Department of Materials Sciences
108 Mineral Industries Building
The Pennsylvania State University
University Park, Pennsylvania 16802
(814) 863-0373

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Mineral Processing Program first initiated in 1945, has opportunities for students to become involved in solving environmental problems as process engineering involves large plants which treat millions of tons of material per year at low cost. The design and operation of these processing plants must allow for the disposal of large quantities of waste materials without damage to the environment. Many air and water pollution control methods use equipment and processes originally deveolped for minerals treatment or processing of minerals of metals and other materials. Students have an opportunity to emphasize pollution control through both course work and thesis research. The program also cooperates with the all-university interdisciplinary program leading to the Master of Science in environmental pollution control or the Master of Environmental Pollution Control.

Excellent employment opportunities exist for mineral process engineers. Demand for personnel significantly exceeds the number of graduates in this field. Employment opportunities exist within the mining. metalurgical, cement, power, and heavy chemical industries as either minerals processing engineers or metallurgists. Graduates may be trained to run a coal cleaning plant associated with mines, for example, and graduates have gone to work with oil companies.

A minerals processing option is being developed within the Mining Engineering Program. The B.S. Minerals processing option within Mining Engineering is scheduled to begin in the fall term, 1978.

Graduate students have access to laboratory and pilot plant facilities within the department plus laboratory facilities located within the Materials Research Laboratory. The minerals constitution laboratory contains excellent analytical equipment and is considered one of the best in the nation. Mineral and particulate-material processing research are included in Energy and Environmental Problems Research conducted by the Department. Specific interests include: sulfur and ash removal from coal; sulfur removal from stack gases; mine and process water treatment; solid waste disposal, recycling, and tuilization; and slagging characteristics of coal.

The program is currently undergoing a change in structure in administration. The Minerals Processing Option will in the future be offered by the Mining Engineering Department. Minerals Processing courses will also split from Metallurgy Program courses which are currently integrated. Minerals Processing staff currently teach an extractive metallurgy option and one courses, Metallurgy 460, Pollution Control in the Mineral Process Industries, has a large wastewater pollution control content.

PROGRAM REQUIREMENTS

Minimum entrance requirements are a recognized bachelor's degree in branch of engineering or science. Included in a students program at the undergraduate level should be mathematics through differential equations, physical chemistry, chemical thermodynamics, elementary geology and mineralogy, and elementary mineral processing.

Students and their research advisors prepare a proposed program of study which is approved by a study panel of three faculty members. The requirements for the M.S. degree include: a minimum of 24 credits of approved graduate courses (6 must be for courses outside the department and 6 credits of research); twenty credits must be earned in residence; a satisfactory seminar on research results must be presented; and a research thesis acceptable to the advisor must be submitted to a committee of faculty members one week prior to the student's oral defense.

The Ph.D. degree does not require any set number of credits but students are normally expected to take a minimum of 15 credits of course work beyond the M.S. degree. Candidates are to demonstrate competence in each of the following areas: general mineral processing; applied sruface chemistry; particle technology; and chemical processes, process metallurgy and thermodynamics. A minor field is also required as is proficiency in a language in which a major body of relevant technical literature exists. The candidate must spend at least three terms as a registered student and a comprehensive examination is required prior to the thesis defense.

Assistantships and fellowships are available from the department. Graduate students receive financial assistance primarily from the research contracts. No special university funding exists for students enrolled in the program.

CURRENT FACULTY, STUDENTS, GRADUATES

Three faculty members (2½ full-time equivalent) contribute to the teaching of the program's curriculum. Each member teaches four to five courses annually and they spend about 50 percent of their time in reserach. Faculty have received research funding for pollution contorl work from the following sources: American Iron and Steel Insitute (Water Pollution from Coal Treatment); Kennedy Van Saum Corporation (use of limestone to prevent sulfur air pollution); and the U.S. Bureau of Mines (Coal preparation discharge).

There are a total of 22 full-time students (no females) enrolled in the program excluding five who are finishing their thesis. All are on research contracts, fellowships or foreign government scholarships. Two students have annually completed graduate degrees over the past ten year period. With increased enrollment, it is expected that seven students will soon annually receive advanced degrees.

Approximately 25 percent of the program's graduates continue on for further education. The majority of graduates who finish the program and find jobs within industry, later return for continued study. Virtually all graduates are employed in the private sector, either in academia or in industry.

PROGRAM PROJECTIONS

Enrollment is dramatically increasing in the program as the demand for graduates by employers is high. Enrollment in the mining area is large and it is expected that over the next ten year period, Penn State will produce 50 to 100 graduates in minerals processing. Fifty percent of the program's research work currently underway is on developing methods of cleaning coal for more efficient pollution control. The program may eventually offer its own bachelor degree program as there is an urgent need to train coal industry personnel.

One additional faculty member (a process engineer with experience in the mineral industry) is needed for the program but no university authorization is expected for hiring.

Job opportunities are so good for mineral processing students with bachelor degrees in the field that few continue on for advanced degree. This poses a recruitment problem for this program that the development of the B.S. option (minerals processing) in the Mining Engineering Program will only partially solve.

COURSE DESCRIPTION (SELECTED)

313 Elements of Mineral Processing - Sampling, sizing, comminution, physical and chemical separation processes, applications to industrial practice. Pollution control. (3 cr.)

404 Design of Pyrometallurgical Systems - Physical-chemical basis for the conversion of ore to metal. (3 cr.)

413 Mineral Processing Laboratory - A laboratory study of the chemical and physical principles involved in practical mineral processing operations. (1 cr.)

414 Extractive Metallurgy Laboratory - Application of basic principles of thermochemistry, thermodynamics and kinetics to extractive metallurgical processes; illustrative of industrial practices. (1 cr.)

420 Mineral Process Engineering - Unit operations for the processing of particulate materials: comminution, screening, classification, slurry pumping, thickening, filtration, etc. Application to mineral processing plant design. (3 cr.)

421 Particle Technology Laboratory - Particle sizing techniques used in mineral separations. (103 cr.)

424 Coal Preparation - Unit operations, flowsheets, and testing methods used in preparation of coal. (3 cr.)

425 Interfacial Phenomena and Flotation - Surface and interfacial phenomena related to flotation agglomeration, flocculation and dispersion of particles. Application to mineral separation and related processes. (3 cr.)

426 Hydrometallurgy - Theory, unit operations and engineering principles applicable to the recovery of metals from ores by chemical methods. (2 cr.)

460 Pollution Control in the Mineral Process Industries - Recycle, utilization and pollution control of air, water and solid wastes from mineral processing plants. Pollution control through process modification. (3 cr.)

501 Interfacial Phenomena in Mineral Systems - Applications of surface phenomena to mineral engineering systems. (3 cr.)

502 Froth Flotation and Agglomeration - Intensive study of theory and applications of froth flotation and agglomeration. (3 cr.)

505 Physical Separations in Mineral Processing - Intensive study of theory and applications of gravity, magnetic, electrostatic, centrifugal and other methods of mineral processing. (3 cr.)

506 Mineral Process Plant Design - Process design and economy. Development and quantification of flow sheets. Integration of unit operations. Plant layout, equipment selection and instrumentation. (3 cr.)

507 Chemical Methods in Mineral Processing - Practice and theory of methods to upgrade ores by chemical treatment including roasting, solubility separations, surface phenomena, and reactions. (3 cr.)

INSTITUTION: UNIVERSITY OF CALIFORNIA, BERKELEY

PROGRAM: Sanitary Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science (M.S.), Master of Engineering (M.Eng.), Doctor of Philosophy (Ph.D.), Doctor of Engineering (D.Eng.) in Sanitary Engineering

CONTACT:
Professor Carl L. Monismith
Dr. Jerome F. Thomas
Department of Civil Engineering
Davis Hall, Room 760
University of California, Berkeley
Berkeley, California 94720
(415) 642-6000

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The College of Engineering, with numerous departments and oragnized research units, offers many avenues for academic study and research in areas of environmental engineering. Traditionally, sanitary engineering has been the oldest of the environmental engineering disciplines, involving supply and treatment of water systems. Sanitary engineering at Berkeley dates back to the early 1900s. Although the scope and structure of the program has changed, the basic philosophy of strong technical background requirements remains unchanged.

Study in environmental engineering areas at Berkeley can lead to the Master of Science degree, the Master of Engineering degree, the Doctor of Philosophy or the Doctor of Engineering degree. The specific objectives and research completed by the student is determined by the degree sought.

Degree programs in environmental engineering are offered as interdisciplinary graduate programs, including civil, mechanical and chemical engineering, or as separate programs through individual departments. For example, air pollution engineering is offered as an interdisciplinary program, as a separate program in the Department of Mechanical Engineering, or through civil engineering. Sanitary engineering, a division of civil engineering, involves the engineering control of our environment. Particular emphasis is given to the development of works designed to improve the quality of the water and air. Areas of concern include water supply development and treatment and reclamation, air and water pollution control, eutrophication control and the development, planning, financing and operating of systems for liquid, solid, and gaseous waste management. The student emphasizing environmental engineering may select courses in both hydraulic and sanitary engineering supplemented with courses in the physical and social sciences depending on a particular interest.

PROGRAM REQUIREMENTS

Students majoring in sanitary engineering have three degree options at the master's level and two at the doctoral level. The majority of students choose the Master of Science in engineering. The M.S. is normally a one year program and may be completed with (Plan I) or without (Plan II) thesis. Plan I carries minimum requirements of 30 quarter units plus a thesis. Graduate work in the major subject requires 12 quarter units. The remaining 18 units may be composed of graduate or advanced undergraduate courses with approval of the major advisor. Plan II students must complete 36 quarter units and a comprehensive final examination. Of the 36 units, at least 18 must be graduate courses in the major subject. The remaining 18 units may be in approved graduate or advanced undergraduate courses.

The Master of Engineering (M.Eng.) is a two year professional degree which began in the fall of 1975. Students must complete a total of 60 to 66 quarter units in approved upper division and graduate courses. One-half of the courses must be completed in the students major field, of which 18 units must be graduate courses. The student must also complete 12 units of graduate or advanced undergraduate courses in technical fields outside the major. For breadth of study, 12 units of graduate or undergraudate courses in humanities, life and social sciences are required. Individual study or research of professionally oriented work at the graduate level is also required. Students may receive between six and 12 quarter units of credit. A written report of the project is also required.

Students who successfully complete master's level work are eligible for advancement to doctoral studies. The degree may be completed in three years, but normally an average of four years, of graduate study, including time spent on the master's degree. Students must chose a major field of study, two minor fields of study, and a thesis. A minimum of 50 quarter units of formal courses approved with the major field advisor are considered necessary to fulfill the major and minor requirements.

CURRENT FACULTY, STUDENTS, GRADUATES

The Department of Civil Engineering at Berkeley is one of the largest in the United States. There are currently over 385 graduate students of which 10% are in sanitary engineering. Faculty members are well known and respected in their fields. As a result, the department is ranked among the top scholastically in the nation.

There are eight full-time faculty members directly involved with sanitary engineering. Each faculty member spends about two-thirds of their time on research and one-third teaching.

The majority of master's students are in the one year M.S. program with 20 students enrolled in sanitary engineering and about 15 graduates per year. Enrollment in the Master of Engineering (M.Eng.) is five with an average of two graduates per year. There are 15 Ph.D. candidates with five graduating annually. The graduate program in sanitary engineering is composed of 20% women and 35% foreign students.

Graduates seeking employment have no problem securing jobs in their field. Within a few months of graduation, 100% of the graduates have jobs. The majority enter the profession as consulting engineers (70%). The remaining graduates find jobs with governmental agencies (25%) or enter teaching positions (5%). Students are placed by means of continuous inquiries coming into the department. This proves to be the most successful method of placement.

PROGRAM PROJECTIONS

The sanitary engineering program at Berkeley has been relatively stable over the past five years. There are no major changes anticipated in faculty or student population.

The department sees a need for a separate program in air pollution control. Rather than having four interdisciplinary programs dealing with air problems, the Department of Civil Engineering hopes to find support to develop a core program, possibly administered by sanitary or medhanical engineering. The sanitary engineering program would also like to palce more mephasis in the areas of waste management. These programs are only long range goals and no tangible plans for the implementation of such programs exist. However, depending on research money and training grants, there programs may become an integral part of the department.

COURSE DESCRIPTION (selected)

Upper division courses:

CE 140 Water Resources Engineering - Planning and design of water distribution systems and wastewater and storm water collection systems, including impoundments, aqueducts, and pumping stations. (4 q.h.)

CE 141 Water Quality Management - Theory and design of water and wastewater treatment plants. Special water conditioning problems including taste and ordor removal, desalinization, and corrosion control. Water pollution control and its relation to process design. (3 q.h.)

CE 142 Design of Water Quality Management Systems - Lectures and discussions of the nature of engineering organizations; role of design in engineering practice; and concepts of systems, process and functional design. (3 q.h.)

CE 143 Applied Ecology - An introduction to some aspects of ecology for those with little or no biological training. Effects of pollution in ecosystems and organisms. Relevant biology for interpretation of changes in ecosystems. (3 q.h.)

CE 144 Environmental and Sanitary Engineering - The biochemical cycles of synthesis and decay, energy resources. The hydrological cycle, drinking water quality collection, treatment, and use. (3 q.h.)

CE 145 Chemistry of Waters - A consideration of the inorganic components in water in terms of water quality. (3 q.h.)

CE 146A Water Resources Chemistry - A systematic consideration of the gravimetric, volumetric and colorimetric analytical techniques involved in the analysis of the major inorganic constituents found in waters. (3 q.h.)

CE 146B Water Resources Chemistry - Emphasis is placed on the analysis and treatment of waters containing organic constituents. (2 q.h.)

CE 147 Organic Chemistry of Water and Wastewater - A consideration of the organic components as a factor determining the quality of wastewaters. Nomenclature and reactions of pertinent organic compounds are emphasized. (3 q.h.)

Graduate courses:

CE 210 Water Resources: Quality - Concepts, rationale, theory, institutions and engineering aspects of water quality management in the ground and surface water environments. (3 q.h.)

CE 211 Water Treatment: Theory and Design - Theory and practice of water treatment for public supply by operations and processes such as aeration, flocculation, sedimentation, filtration, softening, ion exchange, chlorination, and flouridation. (3 q.h.)

CE 212 Wastewater Treatment: Theory and Design - Theory and design of municipal wastewater treatment processes including the unit operations and processes of flotation, sedimentation, activated sludge, and biological filtration including biological process kinetics. (3 q.h.)

CE 213 Water Resources Chemistry: Instrumental Methods - Theory and application of electrochemistry, spectrometric methods, and chromatography to problems of sanitary engineering. (3 q.h.)

CE 215A Advanced Sanitary Engineering Laboratory - Unit operations and processes for municipal and industrial water treatment. (2 q.h.)

CE 215B Advanced Sanitary Engineering Laboratory - Unit operations and processes for municipal and industrial water and waste treatment, lectures and experitrial water and waste treatment, lectures and experiments on water waste and slurry filtration, aerobic and anaerobic biological systems. (2 q.h.)

CE 216 Industrial Waste Control - Theory and design of industrial unit operations and processes to minimize in-process product loss and waste as well as of operations and processes for terminal waste treatment to reduce pollutant emissions to environment. (3 q.h.)

CE 218A Air Pollution-Ambient Air Sampling and Monitoring - Discussion of fundamental chemistry, methods of air analysis and continuous air monitoring of the sic major pollutants. (2 q.h.)

CE 218B Air Pollution-Chemical Aspects of Combustion - Practical aspects of combustion are discussed, primarily from a chemical viewpoint considering topics such as pyrolysis and cracking, oxidation and reduction, recombination reactions, formation of particulate material and other air pollutants. (2 q.h.)

CE 219 Solid Waste Management - Considers major aspects of Solid Waste Management, including transportation and disposal methods. Emphasis placed on interrelationship of management practices, source modification, environmental constraints, and recycling. (2 q.h.)

CE 290L Water Resources Development - The engineering, economic, legal, social and political factors underlying major decisions in water resources development. (2 q.h.)

INSTITUTION: UNIVERSITY OF FLORIDA

PROGRAM: Water Supply and Water Pollution Control

DEPARTMENT: Environmental Engineering Sciences

DEGREE: Master of Engineering (M.E.)
Master of Science (M.S.)
Engineer
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. E. E. Pyatt, Chairman
Department of Environmental Engineering Sciences
University of Florida
Gainesville, Florida 32611
(904) 392-0841

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Although departmental status was authorized in 1966 by the Board of Regents, its geneology may be traced as far back as 1941 in the Department of Civil Engineering. In an effort to not undermine the environmental endeavors of other departments in the College of Engineering, its first name was the Department of Bio-environmental Engineering. This title was conclusively found inappropriate when a correspondent addressed a piece of mail to the Department of Bayou-environmental Engineering. Soon, in 1968, it was renamed the Department of Environmental Engineering Sciences.

The field of environmental engineering is extremely broad; as a result of this, the department has identified several areas on which the student may focus his/her program: air pollution, environmental biology, environmental resources management, radiological health, solid wastes, systems ecology, water pollution control, and water supply, and environmental chemistry.

Research and development in the fields of water supply and water pollution control is advancing at an unprecedented pace. As water and wastewater treatment works strive for compliance with new federal water quality regulations, the theory, design, operation, and supervision of these works become increasingly sophisticated. Professional language, such as demineralization, virus transport, unit operations design, direct reuse, ion exchange, eutrophication, etc., is indicative of this growing technical complexity.

Substantial facilities exist for both teaching and research. Bench-scale facilities exist which allow study, operation, and manipulation of physical, chemical, and biological systems associated with water and wastewater treatment. Traditional wet chemistry apparatus related to water and wastewater analysis, consisting of analytical balances. colorimeters, COD apparatus, drying ovens, muffle furnaces, a room for BOD incubation, refrigerators, micro- and macro-Kjeldahl apparatus, equip the laboratories. Advanced study analytical instrumentation includes an auto-analyzer, gas chromatograph, flourometer, spectrophotometers, polarograph, amperometric titrator, pH meters, conductivity bridge, Toepler pump, vacuum evaporators, and various potentiometric recorders. In addition to the facilities on campus, a variety of sampling and field equipment is maintained for studies on lakes and estuaries near Gainesville.

Research topics which typify activity in the department include: The Effects of Lake Drawdown on Water Quality, The Effects of Sediment Drying on Algal Growth Potential, Eutrophication Factors in North Central Florida Lakes, Bacterial Antibiotic Sensitivity, ATP Content of Marine Zooplankton, Biological Removal of Nutrients from Secondary Sewage, Data Acquisition and Management for Water Quality Control, Estuarine Model for Impact of Man, Characterization and Evaluation of Stormwater Discharge and Non-Sewered Runoff, and Water Resources Planning in Western Canada.

Graduates of this program are prepared to work effectively in the areas of consulting engineering, management, operation of municipal or industrial water and wastewater facilities, and in local, state and federal regulatory agencies.

PROGRAM REQUIREMENTS

Admission to the University of Florida's Graduate School requires an undergraduate degree from an accredited institution with a 3.0 average (on a 4.0 scale) during the junior and senior years, Graduate Record Examination scores, and other evidence of one's ability to do graduate level work.

Two distinct master's programs are available to graduate students in the Department of Environmental Engineering Sciences depending on their educational backgrounds and professional goals. Students who possess undergraduate degrees in engineering or a basic science may pursue the Master of Science degree through a program in Environmental Sciences. Persons with degrees in a non-technical field may be admitted to this program. Commonly, these people have completed at least one year of college-level course work in at least three of the following four areas: chemistry, biology, calculus, and physics. A program in Environmental Engineering leads to a Master of Engineering degree which is accredited by the Engineers' Council for Professional Development. Those who wish to enter this program must be graduate engineers. Other persons wishing to enter this program will be required to take sufficient articulation work to bring their backgrounds into substantial agreement with those having undergraduate engineering training.

Any student who plans to pursue a doctorate degree is encouraged to prepare a master's thesis; however, others in either the M.S. or the M.E. programs have the option of doing a thesis or not, in which case a technical paper must be prepared and presented at a seminar during their final quarter in residence. The minimum registration for a master's degree with a thesis is forty-five quarter credits, thirty-six of which are to be taken in coursework and nine in thesis preparation. Thesis option students must take at least eighteen units of Environmental Engineering Sciences coursework and at least eighteen units of graduate level courses (numbered 600 or higher). The non-thesis option requires a minimum of fifty-four units, twenty-seven of which must be taken within the department and at least twenty-four at the 600 or above level. Students in each option must take eight credits outside of the department. These courses may constitute a designated minor or they may be spread over varied disciplines.

The departmental core requires environmental biology, environmental chemistry, statistics, and computer programming of all students, but beyond this, it is the responsibility of the student and his/her supervisory committee to approve what program of courses is selected. Each student must pass a written and/or oral examination at the completion of his/her course work.

In addition to the departmental core, courses which complement a major in water or wastewater are ENV 500 - Treatment of Wastewater, ENV 531 - Water and Wastewater Analysis, ENV 600 - Advanced Waste Treatment Operations, ENV 601 - Advanced Environmental Engineering Design 1, ENV 602 - Advanced Environmental Engineering Design 2, and ENV 632 - Principles of Water Chemistry 1. There are many courses in this field offered in the department which would satisfy the nineteen elective hours and permit further specialization.

An Engineer degree is available for engineers who require the additional knowledge beyond the master's degree. This degree requires a minimum of forty-five units of graduate work beyond the master's degree, and it falls midway between the master's and the Ph.D. in the amound of work required. This degree is not widely recognized, so its pursuit is not encouraged. It is important to realize than an Engineer degree does not suffice in any way as partial fulfillment of the Ph.D. requirements.

To be admitted to the Ph.D. program, one must have a master's degree. Once admitted, a three person supervisory committee is appointed to guide the student's research and program of study. A minimum of eight quarters in residence is required in order to complete the program. Little course work is specified in order to allow the student and his/her committee a maximum of flexibility in tailoring a program to the needs of the individual. With the committee's approval, a student may choose one or more minor fields, restricted only by the fact that the minor should be unified relative to a clear objective. The Ph.D. candidate must demonstrate proficiency in a language other than his/her native tongue, or must complete a non-technical minor outside of the major field of interest, to be chosen by the supervisory committee. After all of the language requirements have been met and substantially all of the course work is complete, the student must take a qualifying examination for candidacy status for the doctor's degree. The dissertation represents the culmination of the candidate's program and following its defense the Ph.D. degree is awarded.

CURRENT FACULTY, STUDENTS, GRADUATES

The seventeen person faculty usually expends half of its efforts on teaching and half on research, with the exception of three full-time instructors. Eight of these seventeen faculty are chiefly involved with the water and wastewater options.

Enrollment in the graduate program in Environmental Engineering Sciences peaked in 1973 with one hundred and twenty-five students. There are now one hundred and three people enrolled, fifteen of whom are doctoral students. Fourteen research contracts supply financial assistance for graduate students in this program. The enrollment in this department is declining from its 1973 figure because they are not able to provide financial assistance to more of the students.

During 1977 a total of thirty-two graduate degrees were conferred in this department. There were four recipients of the M.E., twenty-two of the M.S., and six of the Ph.D. The Engineer degree has never been awarded. It is not determined how many of these degrees are specific to the water and wastewater concentrations.

A follow-up study of graduates between 1971-1973 shows that of one hundred and thirty-three people who earned master's degrees, twenty-five were employed by consulting firms (most are M.E. graduates), fourteen were hired by industry, nineteen pursued additional degrees, thirteen went to work with health departments, nine accepted EPA and U.S. Public Health Service positions, fourteen are working with other U.S. governmental agencies, and six are teaching in colleges and universities. Thirty-three did not respond to the survey.

PROGRAM PROJECTIONS

The future of this and other similar environmental programs is keenly dependent upon the quality and quantity of assistance and support which is received. It has experienced a slump in enrollment because of training funding cuts. It is anticipated that the demand for graduates such as these will be as great as our environmental situation grows increasingly complex. During recent years, there have been many more positions available for environmentalists than there are properly qualified specialists to fill them.

Because of the withdrawal of federal support for graduate education, competition for financial aid will become increasingly intense. It is felt, however, that when students no longer remember the existence of federal monies the enrollment may be expected to stabilize or increase.

COURSE DESCRIPTION (SELECTED)

ENV 500 Treatment of Wastewater - In-depth study of the physical, chemical and biological processes utilized in treatment of wastewater with emphasis on cause and effect of physical and biological actions. (4 q.h.)

ENV 520 Environmental Biology - Basic cellular organizations and processes related to waste treatment. Role of environmental engineering in maintaining stability of fresh water, marine and terrestrial ecosystems. (4 q.h.)

ENV 522 Environmental Health - Effects of environmental pollution upon health. Methods of evaluation, treatment, and prevention of pollutants of health significance. (4 q.h.)

ENV 531 Water and Wastewater Analysis - Principles of analytical chemistry and their application to determination of chemical composition of natural waters. Emphasis on methods used in routine determinations of water quality and wastewater strength. (4 q.h.)

ENV 600 Advanced Waste Treatment Operations - Biological, physical and chemical processes used in treatment of wastewater. Development of design parameters and operating procedures based on experimentally derived data. (4 q.h.)

ENV 601 Advanced Environmental Engineering Design 1 - Layout and design of sanitary sewerage systems, pumping stations, force mains, wastewater treatment plants and methods of effluent disposal. Design parameters, cost and financing. (5 q.h.)

ENV 602 Advanced Environmental Engineering Design 2 - Development of water supplies, layout and design of distribution systems, pumping and storage facilities and water treatment plants. Design parameters, cost and financing. (5 q.h.)

ENV 611 Water Quality Management - Water quality management applied to streams, lakes and tidal estuaries and embayments. Influence and effects of municipal and industrial wastes on public water supplies, shellfish, storage, recreational uses, industrial uses, and wildlife. (4 q.h.)

ENV 612 Water Management Seminar - Emerging problems and control of water in the environment. Needs for new and better technology and institutional arrangements for management of water. (0-5 q.h.)

ENV 614 Advanced Water Supply Engineering - Current water supply engineering practice, research and new design methodologies. (4 q.h.)

ENV 618 Pollution Transport Systems - Distribution of pollutants in natural waters and the atmosphere. Diffusive and advective transport phenomena. (4 q.h.)

ENV 628 Environmental Microbiology - Study of interaction between microbial populations. Behavior of microorganisms in fresh water, marine and soil environments. Stress due to pollution on microbial communities. (4 q.h.)

ENV 630 Environmental Chemistry - Water treatment, chemical composition of natural waters and other phases of environmental chemistry. Applications of physical and organic chemistry of aqueous and gaseous systems. (1-5 q.h.)

ENV 631 Advanced Water Analysis - Advanced chemical procedures used in water chemistry research. Application of instrumental methods to determination of trace inorganic and organic natural water constituents. (4 q.h.)

ENV 632 Principles of Water Chemistry 1 - Application of chemical principles to reactions and composition of natural waters; emphasizes equilibrium and thermodynamic concepts. (3 q.h.)

ENV 634 Advanced Water Treatment - Advanced concepts in chemical processes of examination and treatment of potable water. (5 q.h.)

EGC 621 Surface Hydrology - Mechanics of occurrence and distribution of water by natural processes including the global energy balance, geophysical fluid motions, precipitation, run-off, infiltration, and water losses. Catchment characteristics and hydrograph analysis. (4 q.h.)

EGC 622 Operational Hydrology I - Frequency analysis of hydrologic events. Hydrologic probability distributions. Analysis and synthesis of hydrologic data. Linear and nonlinear regression. Multivariate analysis of hydrologic signals. (4 q.h.)

EGC 623 Operational Hydrology II - Correlation and spectral analysis of hydrologic signals and systems. Application of linear systems theory to components of hydrologic cycle and total rainfall-runoff process. Criteria for hydrologic instruments and networks. (4 q.h.)

INSTITUTION: UNIVERSITY OF KANSAS

PROGRAM: Water Resources Engineering and Science

DEPARTMENT: Interdisciplinary--administered by Civil Engineering

DEGREE: Master of Science in Water Resources Engineering (M.S.)
Master of Science in Water Resources Science (M.S.)
Doctor of Philosophy in Water Resources Engineering (Ph.D.)
Doctor of Philosophy in Water Resources Science (Ph.D.)

CONTACT: Dr. Ernest C. Pogge
Department of Civil Engineering
1039 Learned Hall
University of Kansas
Lawrence, Kansas 66045
(913) 864-3807

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Instituted in 1962, the programs in Water Resources Engineering and Water Resources Science at the University of Kansas are "designed to prepare engineers and scientists for a career in water resources management". The interdisciplinary options within the courses of study for these master's level programs insure that students not only attain "fundamental knowledge in engineering and physical sciences" but also gain an "appreciation of socio-economic, political, and legal considerations". Students enrolled in these programs "may specialize in a specific area of water technology or concentrate on obtaining a broad base in overall water management".

According to the informational brochure concerning the Water Resources programs:

> Kansas offers excellent opportunities for case study and research of water management problems. There is a wealth of basic hydrologic and geologic data available for water scientists. Typical examples of most of the water-related programs in the nation are available in Kansas, including development and management of surface-and groundwater supplies; flood and erosion control; water quality control; industrial, municipal and agricultural waste treatment; ditch, stream and well irrigation, and development of water recreation. Extensive reservoir and watershed programs within the state provide examples of multi-purpose development for flood control, water supply, irrigation, flow augmentation and recreation.

Facilities include those of all the contributing departments to these interdisciplinary programs, the Hydrology and Water Resources Laboratory, study and research areas in the C. L. Burt Environmental Health Laboratory, the Water Resources Institute, the State Geological Survey, the Department of Geology, and a Honeywell 66/60 computer.

Most research projects are currently funded by the Office of Water Research and Technology and include studies of digital programming of streamflow hydrographs, basin storage and the synthesis of the basin hydrograph, hydrogeology of baseflow in Kansas, water quality models of river basins, soil moisture fluctuations, flow models of principal aquifers in the state, alteration of channel capacity below reservoirs, reservoir regulation and management, groundwater-surface water interaction, social impact of water resources project, development of water-quality criteria, and flood plain management.

PROGRAM REQUIREMENTS

Students seeking the M.S. degree in Water Resources Engineering must possess a B.S. degree from an accredited engineering school. Students desiring the M.S. degree in Water Resources Science must have a B.S. degree in an appropriate field of science. A minimum of 30 semester hours is required for the M.S. degree. All students must take a basic technical core of at least three credit hours of graduate courses in five of the following six areas: groundwater geology, water quality, engineering hydrology, hydraulic and fluid mechanics, meteorology, and water resources. Each student must complete a thesis of not less than six hours or more than ten credit hours. The remaining hours may be selected from engineering, geology, geography, meteorology, mathematics, economics, political science, or law.

CURRENT FACULTY, STUDENTS, GRADUATES

Because of the interdisciplinary structure of the Water Resources programs, the number of faculty involved with these courses of study and the percentage of time each devotes to them vary from year to year. The Civil Engineering Department is responsible for the direct administration of the Water Resources program. Interdisciplinary coordination is provided by a committee chaired by the Vice Chancellor of Research and Graduate Studies and including representatives of engineering, geology, meteorology, and sociology. Eleven staff personnel are involved with the technical core.

There are ten full-time and twenty part-time M.S. students and one full-time and three part-time Ph.D. students enrolled in the Water Resources programs. Research assistantships are available through sponsored research projects and typically allow a student to complete the M.S. degree in three semesters. Eight or nine students graduate annually. Occupations open to them include design and management positions in the water resources area at all levels of government and in engineering consulting firms.

PROGRAM PROJECTIONS

No curricular or staffing changes are anticipated for the next several years. Department personnel contend that the existing programs satisfy the needs of the profession, but additional funding is needed to maintain the current offerings. The Water Resources Engineering and Water Resources Science programs enjoy a reputation for excellence on the University of Kansas campus.

COURSE DESCRIPTION

Technical core courses:

Civil Engineering 730 Intermediate Fluid Mechanics - Continuity principle, stress, rate of deformation, momentum theorem, and energy equation; introduction to potential and viscous flow theories. (3 s.h.)

732 Experimental Fluid Mechanics - Dimensional analysis, model theory, methods of flow measurement, laboratory investigations. (3 s.h.)

750 Water Resources Policy and Administration - An examination of the socio-political, economic, and engineering significance of institutional arrangements affecting American water resources policy, and the application of basic concepts of engineering hydrology, economic projections, and water law to current problems of water resources planning and policy formulation. (3-5 s.h.)

751 Applied Hydrology - The application of various empirical, statistical, and synthetic design techniques to the solution of applied problems in engineering hydrology. (3 s.h.)

755 Free Surface Flow I - A study of non-uniform flow of water in open channels, including backwater curves, the hydraulic jump, and the delivery of canals. (3 s.h.)

776 Water Quality - Water quality requirements for irrigation, recreation, water supply and wastewater disposal with emphasis on interrelationships in streams, rivers, and lakes. (3 s.h.)

830 Advanced Fluid Mechanics I - Advanced topics in non-viscous and viscous flow theory with emphasis on methods of solving problems of potential and laminar flows. (3 s.h.)

850 Application of Optimization Techniques in Civil Engineering - Introduction to the theory and use of optimization techniques in the anlysis of civil engineering systems. Methods covered include the classical calculus and Lagrangians solutions as well as linear, quadratic, dynamic, and geometric programming. Stochastic concepts and problem decomposition are also illustrated via the use of case studies. (3 s.h.)

851 Water Resources Literature Seminar - Review of current literature in water resources. (1 s.h.)

852 Water Resources Research Seminar - Discussion of water resources research with primary emphasis on current thesis research. (1 s.h.)

853 Water Resources Engineering - Appraisal of planning, design, and operational problems in water resources development. Utilization of deterministic and stochastic models in depicting magnitude, equality, and distribution of water supplies. Application of optimization techniques in the economic analysis of multi-purpose projects, operation of river regulation programs, and formulation of basin plans. (3 s.h.)

854 Quantitative Groundwater Hydrology - Theory and practice of the application of quantitative hydrologic methods to the solution of groundwater problems. (3 s.h.)

855 Free Surface Flow II - Continuation of CE 755 including unsteady flows in open channels and theory of water waves. (3 s.h.)

930 Advanced Fluid Mechanics II - Continuation of CE 830 including theory of hydrodynamic stability and theory of turbulent flow. (3 s.h.)

Geology 717 Groundwater Geology - A study of the occurrence and movement of groundwater and methods of determining its availability for use. (3 s.h.)

Meteorology 625 Water Resources Meteorology - A study of the constitution, distribution, and circulation of water in the air-earth system with emphasis on those aspects of the water cycle which are controlled by atmospheric processes and earth surface conditions.

Depending on the individual's qualifications and interests, interdisciplinary options can be developed. The following courses are typical:

Mathematics - probability, statistics, applied mathematics, digital programming.

Economics - public finance, price and income, economic growth and development.

Geology - geomorphology, geophysics, geochemistry.

Geography - soil science, climatology, industrial geology.

Political Science and Law - public policy, public administration, water rights.

INSTITUTION: UNIVERSITY OF KENTUCKY

PROGRAM: Environmental Engineering

DEPARTMENT: Chemical Engineering

DEGREE: Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Robert Grieves, Chairman
Department of Chemical Engineering
University of Kentucky
Lexington, Kentucky 40506
(606) 257-1748

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Chemical Engineering began with the Bachelor of Science degree in 1957. The M.S. followed it in 1967, the year the B.S. became accredited by the Engineers' Council for Professional Development (EPDC); the Ph.D. began in 1969.

Students have several options for specialization; they may elect a conventional chemical engineering curriculum, one in energy engineering[1], or one in environmental engineering. A concentration in environmental engineering will allow a further specialization in air pollution control, water pollution control, or a combination of the two. In the past there existed an EPA-funded M.S. in Air Pollution Control program. Only one student is still involved in this program, and when he graduates the air pollution option may be included in the environmental engineering concentration.

Graduates of the environmental option are in demand by industry, with credentials and capability as environmental engineers and as chemical engineers. They are recruited by pollution control equipment and process companies; by petroleum, chemical and pharmaceutical companies as part of environmental teams; and by specialized companies as pollution engineers. They are valuable to consulting engineering firms specializing in industrial problems. In federal, state, or municipal government, they are uniquely skilled to communicate with chemical engineers in industries which have pollution problems, and to read and interpret plans for new equipment and processes requiring governmental permits.

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[1] A separate description of the energy engineering program is in the Energy volume of this report.

Approximately one-half of the space which this department occupies is devoted to experimental graduate research. Analytical instruments such as IR (infra-red) and UV (ultra-violet) spectrophotometers, an automatic carbon analyzer, several gas chromatographs, a low-temperature asher, a surface area analyzer, and an atomic absorption spectrophotometer are available and operated exclusively by the department. Other more sophisticated instruments are available upon request in other departments. The Engineering Library is located in the same building as the department, and the computer center is adjacent to it. The Water Resources Research Institute (WRRI) is directed by the chairman of the Chemical Engineering Department, and provides research topics in a full range of environmental areas, with several departments involved.

PROGRAM REQUIREMENTS

Students who wish to enter the M.S. program should have taken the Graduate Records Examination; have undergraduate degrees from appropriate ECPD-accredited programs or the equivalent; have satisfactory academic records; and letters of recommendation.

The basic program consists of eight three-semester-credit courses, in addition to a suitable M.S. thesis on an environmental engineering topic. For students with extensive experience in the pollution field, the thesis can be waived and replaced with two additional courses. Considerable flexibility exists in the selection of courses and the thesis topic.

In addition to this M.S. specialization, unique and individualized programs can be designed for the student wishing to pursue a Ph.D. degree with specialization in environmental pollution control. Historically, thirteen Ph.D. degrees have been awarded in chemical engineering.[2]

The candidate for the Ph.D. is usually required to devote no fewer than three years (beyond the B.S. degree) of graduate study to the broad field of chemical engineering, present a satisfactory thesis, and pass a comprehensive examination on his/her thesis subject and chosen field. There is no stipulated number of courses which the Ph.D. student must complete; rather, an individualized program is designed for each student with his/her thesis advisory committee. In order to enable scientific literacy, each student is required to pass a reading examination or a special course in scientific French, German, or Russian.

The environmental programs are unique in that they are strongly oriented to the chemical engineering field, and too because of the broad range of topics available for thesis research. Particular areas are modeling of atmospheric dispersion, aerosol behavior, industrial waste treatment, and physico-chemical separations applied to specific water pollutants.

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[2] Not limited to the environmental engineering option.

CURRENT FACULTY, STUDENTS, GRADUATES

There are ten full-time faculty in chemical engineering; all ten have Ph.D.'s and nine are tenured. A distribution breakdown of departmental efforts is as follows: instruction, 47 percent; administration, 10 percent; professional activities, 10 percent; and research, 33 percent.

In the fall of 1977, there were twenty full-time and five part-time graduate students. Six of these people opted for concentrations in environmental engineering, ten for energy engineering, and the remainder in classical chemical engineering. All of the full-time students are receiving financial aid in the form of graduate fellowships with no teaching or research duties. Most of the students did not do their undergraduate work at the University of Kentucky.

The number of M.S. graduates in 1977 was down slightly from previous years. The average for the five years previous to 1977 was thirteen and in 1977 there were nine.[3]

The campus placement service has been a very effective agent in helping graduates find employment in chemical engineering, just as the professional contacts made by faculty members have been. A follow-up survey traced the employment history of each of the sixty-nine advanced degree graduates in chemical engineering. Thirty-six took positions with industry, twelve accepted governmental jobs (three with the Environmental Protection Agency, one with the Tennessee Valley Authority, and eight with state environmental agencies), six continued their educations, three accepted teaching positions at universities or colleges, two were employed by consulting firms, three were employed by utilities, and two were employed by research institutes.

It is valuable for the graduates in some instances to become certified as Professional Engineers. This registration is on a state-by-state basis, but basically the procedure for each is constant. Upon graduation, a state board examination is conducted at which time those who have passed will receive a training engineer certificate. After five years of practice, a Professional Engineer status is registered. Thirty to forty percent of all chemical engineering graduates will take the examination.

PROGRAM PROJECTIONS

There is a need to establish external funding for environmental engineering specializations. While diversifying the specialties offered in this specialization is an attractive concept, it is not economically feasible at this time. For the time being the plans for this option involve increasing the enrollment slightly and maintaining the current offerings.

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[3] Not exclusively environmental engineering.

ADDITIONAL INFORMATION

In the past there was an M.S. Training Program in Air Pollution Control offered. This option was first funded by the Division of Air Pollution Control of the Public Health Service (now the Environmental Protection Agency) in 1968. Total training money between 1968 and 1977 amounted to approximately $400,000. Nearly all of this money went to M.S. student traineeships. Many of the graduates went to work in the state agencies. There has been no new money available for this training program since 1975, so students have realigned their interests to funded programs. While an air pollution option is offered through the environmental concentration, it has a somewhat different thrust than the M.S. in Air Pollution Control did. It was mentioned previously that one student is still in this degree option, but with his graduation this option may be terminated.

COURSE DESCRIPTION

CME 505 Analysis of Chemical Engineering Problems - Application of numerical methods, differential equations, and transforms to complex chemical engineering problems. (3 s.h.)

CME 515 Air Pollution Control - Kinetics and equilibria of photochemical and "dark" atmospheric reactions. Atmospheric statics and dynamics including lapse rates, inversions, and vertical and horizontal air motion. Single and area source diffusion. (3 s.h.)

CME 565 Energy Engineering - Energy supply and demand, material and energy balances for fossil fuel to fuel conversion including thermodynamic considerations, analysis of electrical power generation by conventional methods and by potential methods. (3 s.h.)

CME 580 Design of Rate and Equilibrium Processes for Water Pollution Control - Design of chemical and physical processes for the removal and concentration of organic, inorganic, and particulate pollutants from aqueous solution/suspension; absorption, destabilization, disinfection, membrane processes, thermal processes, flow through beds of solids, etc. (3 s.h.)

CME 615 Advanced Air Pollution Control - Principles and techniques of control of atmospheric pollution, including process design for the removal of gaseous and particulate pollutants from air streams. Legal and administrative aspects of control. (3 s.h.)

CME 617 Air Sampling and Analysis - Theory and techniques of air sampling, including aerosol sampling. Instrumental, gravimetric, and volumetric analysis of gaseous and particulate air pollutants with emphasis on modern methods of instrumental analysis. (3 s.h.)

CME 619 Community Health Aspects of Air Pollution Control - Effects of specified pollutants on humans, materials, and the environment. Solid waste disposal by incineration. Air pollution control and water pollution control interrelationships. (3 s.h.)

CE 663 Water Quality Control Laboratory II - Laboratory scale studies and evaluations of water pollution control processes and techniques. (3 s.h.)

CE 669 Water Quality in Surface Waters - Analysis of dispersion, advection, evaporation, natural aeration, biological oxidation, and photosynthesis; their effects on the physical, chemical, and biological quality of waters in streams, lakes, etc. Eutrophication. Water quality requirements. (3 s.h.)

CME 680 Biochemical Engineering - Principles and design processes involving bio-chemical reactions, including aerobic and anaerobic respirations and fermentations, and involving pure and mixed cultures. Energy considerations, heat and mass transfer, biochemical kinetics, and application to biological waste treatment. (3 s.h.)

INSTITUTION: UNIVERSITY OF MAINE - ORONO

PROGRAM: Sanitary Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science degree in Civil Engineering in the areas of Sanitary, Soils, Structural, and Highway Engineering
Doctor of Philosophy in Sanitary Engineering

CONTACT:
Dr. Willem I. Brutsaert
Civil Engineering Dept.
355 Aubert Hall
University of Maine
Orono, Maine 04473

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The University of Maine's sanitary engineering program since inception during the mid-1960s has been predominantly oriented toward water topics. The unique geographical location of this land-grant institution provides excellent outdoor laboratory opportunities for students interested in either lake or water resources research.

At the undergraduate level, students can take basic sanitary engineering courses which concentrate on the theory, design, and control of water treatment plants and unit process for water, air, and land pollution abatement. Students are also offered courses in both chemistry and microbiology in sanitary engineering. In addition, courses are offered in the areas of hydrology, hyraulics and soils engineering.

Graduate courses are available in water resources, engineering, radiological health, industrial wastes, public health engineering, and design of both water treatment and wastewater treatment plants. All graduate students are required to participate in a sanitary engineering seminar during which current research topics are both individually presented and discussed.

PROGRAM REQUIREMENTS

In order to enter the M.S. program, applicants are usually required to have a B.S. degree in Civil Engineering, from an accredited institution. Prospective applicants who do not meet this requirement may have to take courses for no graduate credit.

For the Master of Science degree, a minimum of thirty semester hours, including thesis credits, is required. All M.S. candidates are required to prepare a thesis as well as complete a minimum of 12 hours (exclusive of thesis) of 200 and/or 300 level graduate course work as a part of the thirty semester hour requirement. The thesis credit amount is a minimum of six hours.

The Doctor of Philosophy degree in Sanitary Engineering emphasizes original research and represents approximately 50 percent of the program beyond the B.S. degree. No more than 30 semester hours of transfer credit is accepted and the degree must be completed within four years of admission to candidacy. The dean of the graduate school appoints the student's advisory committee and the student's major or thesis advisor serves as chairperson. Competence in one foreign language is required and proficiency is determined by a written examination involving translation of technical literature.

Graduate students can obtain financial assistance from such sources as: Department teaching or research assistantships; highway fellowships for State Highway Commission employees; and various other fellowships and scholarships.

CURRENT FACULTY, STUDENTS, GRADUATES

The Civil Engineering Department has a total of 14 faculty positions of which five are concerned with sanitary engineering topics. All five teaching positions are staffed with two sanitary engineers (one with a water chemistry background), one hydrologist, one water resources engineer, and an environmental engineer with a coastal research background. One associate faculty member is director of the Water Resources Center with a special interest in Lake Systems and fresh water quality problems.

There are currently (fall, 1977) fourteen full time students enrolled in the program of whom two are female. Some students have entered the M.S. program with microbiology or geology backgrounds. Normally, an average of five to seven students receive the M.S. or Ph.D. degree annually.

Few students (one out of ten) continue to receive their doctorates at other educational institutions and those that have continued have gone to Purdue among others. Officials have stated that one hundred percent of the M.S. students have found employment and about seventy-five percent have obtained jobs in the private sector, mostly consulting firms. The other twenty-five percent have found public sector jobs with such agencies as the State Department of Environmental Protection, the U.S. Environmental Protection Agency, and various state planning agencies.

PROGRAM PROJECTIONS

The sanitary engineering program at the University of Maine is expected to expand into a broader environmental engineering program with emphasis on the study of coastal and inland waters. The Master of Science in Civil Engineering will allow students to select options in the following areas: sanitary engineering; coastal engineering; hydrology; and water resources engineering. During 1978 two additional faculty members are expected to be recruited for this expansion. One environmental engineer with research backgrounds in coastal processes and estuaries problems will be hired by the fall term of 1978. The other addition will be a sanitary engineer with research expertise in water chemistry and this second person is expected to be hired by the spring term, 1978. Generally, program officials expect environmental programs to stay at a stable level and maintain a status quo. However, the University of Maine program is expected to recruit additional students who are interested in water resources study relating to coastal and inland waters.

COURSE DESCRIPTION

Graduate courses:

200 Applied City and Regional Planning - The practice of city and regional planning and the preparation of regional and urban plans. (3 s.h.)

230 Water Resources Engineering - Development, control, and engineering of water resources systems. (3 s.h.)

240 Radiological Health - Atomic structure, radioactivity, Decay Law, interaction of radiation with matter, sanitary engineering application of radiation and radioactive waste disposal, and other topics. (3 s.h.)

320 Physicochemical Processes for Water Quality Control - Principles of physical and chemical unit operations applied water and wastewater treatment. (3 s.h.)

322 Biological Processes for Wastewater Treatment - Principles of biologic unit processes applied to wastewater treatment. (3 s.h.)

323 Industrial Wastes - Study of the principles and practice of industrial waste treatment. (4 s.h.)

324 Public Health Engineering - Subjects include epidemiology, housing, air pollution, radiological health, and others. (3 s.h.)

330 Sanitary Engineering Design I and II - The functional design of a water treatment plant, and in the second part, of a wastewater plant. (3 s.h.)

INSTITUTION: UNIVERSITY OF MISSOURI-ROLLA

PROGRAM: Environmental and Sanitary Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science in Civil Engineering (M.S.)
Doctorate in Civil Engineering (Ph.D.)

CONTACT: Dr. J. H. Senne, Chairman
Department of Civil Engineering
University of Missouri-Rolla
Rolla, Missouri 65401

Dr. Ju-Chang Huang, Area Head
Environmental & Sanitary
Engineering Program
Department of Civil Engineering
University of Missouri-Rolla
Rolla, Missouri 65401

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This program is administered by the Department of Civil Engineering and is open to qualified students in engineering and related physical and life sciences. It offers a strong and well rounded curriculum consisting of graduate training and research in the areas of water and wastewater engineering, air pollution control, and solid waste management. It is well supported with departmental offerings in other areas, primarily water resources engineering, hydrology and hydraulic engineering, environmental and planning engineering; complemented with courses in other engineering and science disciplines; and strengthened by a strong and expanding research program.

PROGRAM REQUIREMENTS

Graduate study in environmental and sanitary engineering usually leads to the Master of Science and Doctor of Philosophy degrees in Civil Engineering. There are two programs available to the students at the master's level; the first requires a minimum of 30 semester credit hours and the preparation of a research thesis, while the second is a non-thesis degree requiring at least 33 semester credit hours. In both cases at least six semester hours must be taken outside the Civil Engineering Department. Most students undertake the thesis option. Depending upon their background and experience, students who have not received their undergraduate training in civil engineering might be required to take deficiency undergraduate work in water and wastewater engineering in order to better prepare themselves for the graduate program.

Beginning with the Fall 1971 semester a program has been offered at the UMR St. Louis Graduate Engineering Center, and today approximately 35 practicing engineers and scientists from the Greater St. Louis area are pursuing graduate study leading to the M.S. degree on a part-time basis.

Graduate course offerings include water and wastewater engineering, air and water resources, solid waste management, and a selected group of supporting courses in engineering and science. Each student formulates with the advice and consent of his advisor, an individual program of graduate study and research which is best adapted to his own interest and preparation. While considerable emphasis is given to basic sciences and fundamental concepts so necessary for understanding sanitary engineering processes and operations, the main thrust is toward engineering.

CURRENT FACULTY, STUDENTS, GRADUATES

The faculty consists of seven full-time professors under the direction of a program area head. Four professors and the area head are Professional Engineers.

Currently, eleven men and two women are enrolled full-time in the masters program; there is one doctoral student. The program offers off campus courses in St. Louis; 45 persons are enrolled as part-time masters students in St. Louis.

Graduates have little difficulty finding employment. They often have several offers. About half take positions in the public sector and half in the private sector.

PROGRAM PROJECTIONS

No changes in program structure are anticipated in the near future.

ADDITIONAL INFORMATION

The program frequently offers short courses for Professional Engineers in the field. Environmental impact assessment seminars have been presented.

COURSE DESCRIPTION

(The following is a partial listing of courses)

Chemistry: 355 Instrumental Methods of Chemical Analysis - Special analytical techniques including colorimetry, electrometric methods, electrolytic separations, polarography, spectrophotometry, X-ray spectroscopy, flame photometry and radiochemistry. (3 s.h.)

373 Atmospheric Chemistry - A chemical study of the troposhere including composition; nucleation, growth stability, distribution, diffusion, and fallout of aerosols; and meteorological aspect. (3 s.h.)

Civil Engineering: 309 City Planning - Consideration is given to each of the six major subdivisions of city planning, 309 (Cont'd) - comprising streets, transit, transportation, public recreation, zoning and civic art; history of city planning; laws governing various phases. Work includes a city layout on a topographic map with attention paid to probable future development of the city concerned. (2 s.h.)

327 Advanced Structural Design - The design of structural systems to formalize the student's knowledge of the behavior of individual components into a final integrated structure. Continuous span highway bridges, culverts, retaining walls, rigid frames, multi-storied buildings and similar type problems of interest to the student. (3 s.h.)

331 Hydraulics of Open Channels - The phenomena accompanying the flow of water in open channels, such as uniform and varied flow, critical conditions, shooting flow, backwater curves, hydraulic jump, drop, and applications are studied in detail. (3 s.h.)

333 Intermediate Fluid Mechanics I - Kinematics of fluid motion, conservation of mass, linear and angular momentum, and energy. Requirements for similarity of fluid flow. Introduction to dynamics of ideal fluids and viscous incompressible flows. Comparison of control volumes and system approaches. (3 s.h.)

336 Intermediate Fluid Mechanics II - Continuation of C.E.333 at an advanced level. General considerations of irrotational and axially symmetric incompressible irrotational flows. Advanced studies of viscous incompressible flows. Introduction to boundary layer theory. (3 s.h.)

338 Hydrologic Techniques - A study of current up-to-date hydrologic techniques involving design of hydrologic input for bridges, culverts, reservoirs. Techniques involve extreme value statistics, model hydrographs, routing, etc. (3 s.h.)

362 Public Health Engineering - A comprehensive course dealing with the environmental aspects of public health. (3 s.h.)

363 Solid Waste Management - A systematic study of the sources, amounts and characteristics of solid wastes and methods used for their collection, reclamation, and ultimate disposal. (3 s.h.)

364 Solid Waste Laboratory - A companion course to CE 363 for those students desiring experience in refuse characterization, analysis and quantity determinations along with disposal operational controls. (1 s.h.)

365 Sanitary Engineering Analysis - Quantitative measurement and benchscale pilot plant investigation in the fields of water, sewage, industrial waste, and stream pollution. Interpretation and application of test data. (3 s.h.)

367 Air Pollution Abatement I - Comprehensive study of air pollution abatement with emphasis on sources, causes, effects, and general control methods. (3 s.h.)

368 Air Pollution Abatement II - Comprehensive study of air pollution abatement with emphasis on sampling, measurement, and control. (3 s.h.)

369 Sanitary Engineering Design - Functional design of water and wastewater treatment facilities. (3 s.h.)

380 Water Resources and Engineering - Application of engineering principles to the planning and design of multipurpose water resources projects. Latest concepts in engineering analysis are utilized to enable the student to ultimately evaluate alternative solutions to water resources problems.

400 Special Investigations - Advanced work, individual in character but not leading to a thesis. (s.h. arranged)

401 Special Topics - Special lectures in an area of civil engineering of immediate interest to graduate students, which may develop into a continuing graduate course. (s.h. variable)

431 Advanced Hydraulics and Hydraulic Engineering - Studies in the field of hydraulic engineering to fit the needs of a particular student or class. Each student makes a complete design of a hydraulic development in one of the following fields; water power, sanitation, river and harbor projects. (s.h. variable)

438 Advanced Hydrology - A study of methods used in modern hydrologic analysis and design. Items of study include hydrograph analysis, maximum possible storm, infiltration, design flood determination and project feasibility. (3 s.h.)

439 Similitude and Model Studies - The use of models and analogies as aids to engineering design. Principles of dimensional analysis. Application to problems of fluid flow and structures is emphasized. (3 s.h.)

440 Urban Hydrology - Studies of the influence of urban areas on their hydrology. Special emphasis on the principles of spatially varied unsteady flow. Model hydrographs leading toward determination of design storm flow are utilized to obtain information necessary for design of storm sewers, channels, and hydraulic structures common to urban areas.

461 Sanitary Microbiology - A study of the principles and applications of the microbiology involved in environmental health and water resources engineering. (3 s.h.)

462 Water Treatment - A detailed study of the theory of water treatment with applications to design and operation. (3 s.h.)

463 Waste Water Treatment I - A detailed study of the theory of sewage and industrial waste treatment with applications to design and operation including consideration of receiving waters. (3 s.h.)

464 Waste Water Treatment II - A comprehensive study of the fundamentals of industrial waste treatment and characterization including laboratory pilot plant investigations. (3 s.h.)

469 Advanced Sanitary Engineering Design - A detailed study of the functional design of modern water purification and sewage treatment plants with emphasis on unit operations and processes. (3 s.h.)

480 Water Resources Engineering I - A study of water resources. Consideration is given to the conception and planning for developments to control and utilize water resources, including historical, institutional, and legal aspects. (3 s.h.)

481 Water Resources Engineering II - The design, construction and operation of developments to control and utilize water resources. The student's background in engineering science, design, humanities, and social sciences is drawn upon to include all aspects of a project. (3 s.h.)

Engineering Management: 314 Organizational Theory and Corporate Structure - Development of the theories and practices of planning, controlling, organizing, and directing the industrial enterprise. Application of these management theories to the functional elements of the corporate organization. (3 s.h.)

327 Legal Environment - Study of the effect of the legal environment on the decisions which the engineering manager must make. The course investigates the social forces that produced this environment and the responsibilities incumbent upon the engineer. (3 s.h.)

386 Safety Engineering Management - Principles of safety engineering applied to industrial situations; job safety analysis and specification of solutions; reduction of accident rates, frequency and costs; protective equipment, jigs, fixtures and standards, rules, regulations and laws. (3 s.h.)

456 Advanced Personnel Management - Current practices of procurement and maintenance of technical personnel in research, development, and design organizations. Adaptation of such personnel to the technological enterprise, current practices in personnel administration, labor management relationships. (3 s.h.)

INSTITUTION: UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

PROGRAM: Environmental Chemistry and Biology (ECB)

DEPARTMENT: Environmental Sciences and Engineering

DEGREE: Master of Science (M.S.)
Master of Science in Public Health (M.S.P.H.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Russell F. Christman, Professor and Chairman
Department of Environmental Sciences and Engineering
School of Public Health
The University of North Carolina
Chapel Hill, North Carolina 25714
(919) 966-1171

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Environmental Sciences and Engineering is a component of the School of Public Health of the University of North Carolina at Chapel Hill. The school is one of five professional schools in the university's Division of Health Sciences, and is one of the nineteen such schools in the U.S. accredited by the Council on Education for Public Health. Graduate study and research in sanitary engineering were initiated in 1921. The program continually expanded and became Environmental Sciences and Engineering in 1962. In addition to Environmental Chemistry and Biology, the department offers graduate instruction in four other programmatic areas: Air and Industrial Hygiene, Environmental Management and Protection, Radiological Hygiene, and Water Resources Engineering.

The major goal of the ECB program is to integrate the basic principles of chemistry and biology with problems of aquatic pollution and environmental deterioration. Basic science concepts are applied to the real world problems of water treatment processes, metal transport, applied limnology, microbial ecology, environmental virology, wetlands ecology and organic pollution in the aquatic environment. Master's students can earn the M.S., M.S.P.H. and Ph.D. degrees. The M.S.P.H. degree has a public health focus, and is intended for those students who are preparing for scientific, technical, and managerial responsibilities with local, national and international agencies and government, consulting engineers and industry. To pursue similar career objectives, M.S. candidates may place more emphasis on thesis research. Master's students are prepared for careers in the sciences of water resources, limnology, aquatic ecology, environmental microbiology and virology, and pollution control. The degree programs prepare them to serve as environmental managers, directors of field and laboratory research projects, and as members of teams in water resources management and process development.

Study for the Ph.D. is intended primarily for those preparing for careers in teaching are research; Ph.D. graduates are employed as professors in many colleges and universities, and as environmental managers and directors of major environmental laboratories. Some graduates are also employed as administrators and researchers in local, national and international agencies, government, and industry.

The department places heavy emphasis on research, and is involved with over seventy separate research and grant contracts in diverse environmental fields. Current faculty research projects are funded through such agencies as the Environmental Protection Agency (EPA), the UNC Water Resources Research Institute, the U.S. Army Medical R&D Command, the National Science Foundation, and the State of North Carolina. Student research projects are usually part of a larger team effort sponsored by a research grant, which often provides financial support.

In addition to the Water Resources Research Institute, the department is involved with a number of other special programs related to the ECB area. The Institute of Marine Sciences of the university has extensive research and teaching facilities at Morehead City, on the coast, which are made available to students in the department. Extensive limnological laboratories and research vessels make possible studies on the chemical and biological characteristics of surface waters. The UNC Wastewater Research Center provides opportunities for research with laboratories and pilot plant facilities. Modern analog and digital computers, as well as shop facilities are also available to all departmental students.

A large variety of chemical instrumentation and equipment is available in the ECB program for class work and student research projects. These include gas chromatographs, atomic absorption spectrophotometers, recording UV-visible spectrophotometers, and carbon analyzers. Arrangements for the use of a gas chromatograph-mass spectometry facility of the National Institute for Environmental Health Sciences at Research Triangle Park, can be made.

Chemical and microbiological laboratories contain routine equipment for standard tests and cultures, as well as several illuminated Warburg respirometers, two phase-contrast photo microscopes, autoanalyzers, and a closed circuit television camera and monitor. Also available in the department are four large gas chromatographs, a high pressure liquid chromatograph, and radiation counting equipment.

PROGRAM REQUIREMENTS

For admission into the department, all candidates must submit at least two letters of academic reference, a statement of career objectives, the aptitude portion of the Graduate Record Examinations, and transcripts from all institutions attended (the average grade point for all new ECB students in the fall of 1977 was 3.47, the average GRE score, 1207). For doctoral students, a statement of research interests is also required.

The master's degree programs in ECB are intended for students with bachelor's degrees from an approved school in a program that included a minimum of twenty-seven semester hours in chemistry and biology. Students should also have completed at least one semester of college level physics and courses in mathematics through integrated calculus. Entrance into the Ph.D. program normally requires a previous master's degree in an allied field. Admission to this degree program requires the sponsorship by a faculty member who agrees to serve as the student's program advisor.

School of Public Health requirements for the M.S.P.H. include a basic biostatistics course, a basic epidemiology course, and five departmental courses, or fifteen hours, in a field consistent with the program area. Students pursuing this degree must select a topic and develop an acceptable technical report and register for ENVR 392 for at least three credits in the completion of the report. Programs of study for M.S. candidates are individually designed by the student in consultation with his/her faculty advisor. M.S. candidates must complete and defend a formal thesis. Reports and theses may be laboratory or field projects, and are presented during the required oral comprehensive examination. A minimum of thirty semester hours is required in the completion of the master's degrees, and the program of study normally lasts eighteen to twenty-four months.

Although the ECB program allows latitude in course selection, generally course work is concentrated in either environmental chemistry or biology. Track I, environmental chemistry, requires three courses in each of the following areas: ecology, biology, engineering unit processes, techniques and applications, environmental protection, and environmental sciences electives. Track II, Environmental Biology, requires two courses each in ecology and biology, and one course in each of the areas of chemistry, engineering unit processes, techniques and applications, environmental protection, and environmental sciences electives.

There are no formal course requirements for the Ph.D.; a program of study is developed with the student's committee to provide mastery in the chosen field. In addition to the major, doctoral candidates must have a supporting program of at least fifteen hours; a formal minor may be elected. Two courses in a research skill are required, and all course work is examined at the time of a written examination. An approved dissertation must be prepared that is expected to be a significant and original contribution to knowledge. This is presented and defended at a final oral examination. Registration in ENVR 394 for at least three credit hours is required in the completion of the dissertation.

Approved courses in the ECB program area are detailed in the Course Description section. Descriptions are provided only for those courses offered by the department; approved courses in other departments are listed only.

CURRENT FACULTY, STUDENTS, GRADUATES

Seven full-time departmental faculty members, including the department chairman, have primary research and teaching responsibilities and interests in the ECB program area. Two faculty members have major responsibilities in the Water Resources Engineering program but also teach ECB courses. Another holds a joint appointment with the department (in ECB) and with the UNC School of Medicine. In addition, three adjunct professors provide support to the program on a part-time basis. All faculty members hold the doctorate degree, with major teaching/research responsibilities in a variety of areas related to environmental chemistry and biology.

During the 1977-1978 term, twenty-five students are seeking master's degrees in the ECB program, as well as twelve students pursuing the Ph.D. This enrollment represents a gradual increase over the last ten years. Of these, three are self-supporting; the remainder receive assistance through fellowships, training grants, and assistantships. The number of training grants available to students has reduced substantially in recent years.

Five persons graduated with the M.S.P.H. degree in the ECB program area in 1975-1976, as did one person with the M.S. degree. During 1976-1977, four received the M.S.P.H. degree and three the M.S. Of these thirteen graduates, the employment status of two is unknown; two are research assistants at the university, one is teaching at another university, one accepted a governmental position, and six accepted positions in consulting firms or industries. One is pursuing the Ph.D.

PROGRAM PROJECTIONS

The student enrollment in the department and in the specific programs is not expected to increase, as the department is currently authorized to admit only as many students as it graduates. In an effort to improve communication skills of Ph.D. students, the ECB program may require that all Ph.D. candidates teach courses one year before being awarded the degree.

A major departmental programmatic change may take place within the year. Under discussion is the development of research and course offerings on the effects of contaminants on human health. As envisioned, such a development would embrace such diverse disciplines as toxicology, medicine, pharmacology, and oncology, and would tackle subjects such as the relationship of water quality to cancer incidence and the effects of air discharges on upper respiratory ailments. How this new emphasis will be incorporated into the current departmental structure is as yet undecided. A research committee has been formed to study the alternatives and provide recommendations; monies are available for several new faculty members; and efforts are underway to secure new research grants in this area.

COURSE DESCRIPTION

Approved chemistry courses:

ENVR 122 Water Chemistry - Principles and applications of water chemistry. Consideration of equilibrium relationships in aqueous solutions such as natural waters. Thermodynamic background for equilibrium calculations, including free energy and activity relationships. (4 s.h.)

ENVR 123 Organic Materials in Natural Waters - Origins of natural product organic materials in rivers and lakes. Synthetic organic waste sources, microbial transformations, metal transport properties. Organic water quality monitoring and rationale for water quality criteria and standards. (3 s.h.)

ENVR 222 Special Topics in Aquatic Chemistry - Modern topics in aquatic chemistry, application of chemical concepts to the understanding and control of aquatic environment. (2 s.h.)

ENVR 223 Trace Analysis - Sampling and sample preparation; electromechanical, spectrophotometric, and nuclear techniques; chemical speciation; precision and validation of results. Laboratory with environmental samples. (3 s.h.)

CHEM 160 Intermediate Organic Chemistry

Approved biology courses:

ENVR 131 Biology in Environmental Science - Introduction to biology, including principles of bio-chemistry, cell structure, classification, ecology. Application to public health, including biology of waste treatment systems, biological indices of pollution, water and airborne diseases. (3 s.h.)

ENVR 132 Limnology and Water Pollution - The principles of limnology as they apply to water supply and waste disposal. Emphasis on physical, chemical, and biological factors of the aquatic environment. (3 s.h.)

ENVR 133 Environmental Biology - Overview of environmental biology with emphasis on ecological theory as it relates to applied biological problems. Metabolism of individuals, reaction of populations and communities to environmental stress, ecosystem responses to perturbations. (3 s.h.)

ENVR 134 Environmental Microbiology - Principles of general microbiology: examination of microbial world with emphasis on nonpathogenic bacteria, their cytology, growth, physiology, and significance in the environment. (3 s.h.)

ENVR 138 Environmental Virology - Ecological, environmental health and fundamental aspects of virology, with emphasis on viruses in air, water and food. (4 s.h.)

ENVR 232 Special Topics in Aquatic Biology - Topics of contemporary concern to the management of the aquatic environment, e.g., movement of pesticides through aquatic food chains; growth of algae and nutrient levels. (2 s.h.)

ENVR 236 Advanced Topics in Limnology

BIOC 100 Biochemistry for Students in Biology and Chemistry

Approved ecology courses:

ENVR 135 Ecology - (3 s.h.)

ENVR 137 Ecology of Wetlands - Introduction to the functioning of freshwater and estuarine marsh and swamp ecosystems, with emphasis on systems of southeastern U.S. (4 or 6 s.h.)

ENVR 233 Microbial Ecology - Consideration of the factors that influence distribution and interrelationships of microorganisms in their natural habitat, with emphasis on non-pathogenic bacteria. (4 s.h.)

ENVR 235 Ecology of Phytoplankton - Relationships of planktonic algae to their physical, chemical and biotic environment, with emphasis on nutrition and primary productivity. (4 s.h.)

ZOOL 226 Systems Ecology

Approved engineering unit processes courses:

ENVR 174 Water and Wastes Treatment Processes - Unit processes for water and wastewater treatment. Gas transfer, coagulation, disinfection, absorption, demineralization, sedimentation, filtration, aerobic and anaerobic biological treatment. (3 s.h.)

ENVR 274 Advanced Water and Waste Treatment Processes I - Applications of chemical, physical, and biological principles to water and wastewater treatment. Equilbria, kinetics and reactor performance. Physical and chemical processes including sedimentation, filtration, absorption, ion exchange, coagulation, precipitation. Laboratory exercises illustrate. (3 s.h.)

ENVR 275 Advanced Water and Waste Treatment Processes II - Continuation of 274 with emphasis on process of aerobic and anaerobic biological treatment, gas transfer, solids handling, ENVR 275 (Cont'd) - nutrient removal, and membrane processes. Laboratory included. (3 s.h.)

Approved techniques and applications courses:

ENVR 221 Instrumental Methods of Analysis - Principles and techniques of instrumental chemical analysis, including optical, electrical and separation methods. Laboratories include absorption and emission spectrophotometry, potentiometry, amperometry, coulometry, and gas ion exchange and chromatography. (4 s.h.)

ENVR 231A Limnological Methods - Professional study for field study of freshwater aquatic systems. (2 s.h.)

Approved environmental protection courses:

ENVR 211 Environmental Management - Analysis of decision-making for environmental protection programs including policy development, program implementation and management approaches. Case studies of specific environmental protection problems. (3 s.h.)

ENVR 215 Environmental Issues and Assessment - Concepts and methodologies for assessing the environmental, ecological and social consequences of technological development. Preparation of environmental impact statements and case studies. (2 s.h.)

Approved environmental science electives:

ENVR 141 Elements of Air Hygiene - Health aspects of the air from standpoint of community pollution. Chemical and physical behavior and biological effects of air contaminants. Means of controlling air pollution. (2 s.h.)

ENVR 143 Applied Physiology and Toxicology - Physiological response of various organs and organ systems of the body to the physical and chemical stresses of the industrial environment. Methods of industrial toxicology and the toxicological basis for the Threshold Limit Values. Concentration-Time equivalence, routes of entry, synergism are investigated in the laboratory. (3 s.h.)

ENVR 171 Water Quality Evaluation and Control - Characteristics of water as a resource. Water uses, trends. Water quality concepts, measurements, criteria, problems, pollutants. Water supply and wastewater treatment and disposal systems. Regulation of water quality standards. (3 s.h.)

ENVR 283 Natural Resource Law and Policy - Examination of law of resource use and development. (3 s.h.)

INSTITUTION: UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

PROGRAM: Water Resources Engineering (WRE)

DEPARTMENT: Environmental Sciences and Engineering

DEGREE: Master of Science (M.S.)
Master of Science in Public Health (M.S.P.H.)
Master of Science in Environmental Engineering (M.S.E.E.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Russell F. Christman, Professor and Chairman
Department of Environmental Sciences and Engineering
School of Public Health
The University of North Carolina
Chapel Hill, North Carolina 27514
(919) 966-1171

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Water Resources Engineering is one of five program areas within the Department of Environmental Sciences and Engineering of the School of Public Health at the University of North Carolina at Chapel Hill. The other areas are: Air and Industrial Hygiene, Environmental Management and Protection, Environmental Chemistry and Biology, and Radiological Hygiene. The objective of the WRE program is to develop engineering professionals with the knowledge, technical skills, and social attitudes necessary for efficient entry and growth in water resources engineering careers.

Within this program area, the master's degrees of M.S.E.E., M.S., and M.S.P.H. are offered. The M.S.E.E. program is accredited by the Engineers' Council for Professional Development (ECPD). Master's graduates have adequate knowledge and capabilities to participate in investigating, planning, designing, constructing, operating, and regulating systems and programs for the development, utilization, and protection of water resources. A Ph.D. program is also offered, which is chiefly geared toward training academicians in all aspects of water resources engineering. These graduates also may find employment with research organizations, industries and consulting firms, as well as with local, state, national and international organizations concerned with the investigation and control of water resources.

Research in the WRE program emphasizes problem areas in the preservation and management of the human environment. All WRE students have the opportunity to conduct research with faculty participation and guidance. Ongoing projects represent a broad mix, which include sponsored projects that often provide equipment, supplies, experimental space, and stipends. Current sponsored projects in the WRE area include a study of absorption of trace metals on activated carbon, research regarding ozonation of phenol and substituted phenols

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in aquatic systems, regional water planning, the development of an equilibrium model for phosphorus in anoxic waters, development of nutrient models, water management in coastal North Carolina, and a study of the effects of prechlorination of humic substances. Support comes from such sources as the UNC Water Resources Research Institute, the U.S. Public Health Service, the UNC Research Council, and the National Science Foundation.

The UNC Water Resources Research Institute promotes a multidisciplinary focus on water problems and develops and supports research in response to the need to increase and protect the state's water resources. It encourages the development of educational programs, coordinates educational and research programs, and provides a link between the state and federal water resources agencies and the related interests in the university. The WRRE receives financial support from annual allotments and matching grants from the Office of Water Resources Research, U.S. Department of the Interior, nonfederal matching and other funds from the state, and grants from private foundations.

Other university programs and facilities that provide support to the graduate WRE program area are the Institute of Marine Sciences, limnological laboratories, and the UNC Wastewater Research Center. The institute has extensive research and teaching facilities at Morehead City, on the North Carolina coast, which are made available to faculty and students with research interests in geological, biological, physical and chemical oceanography, and related fields. The limnological laboratories allow studies on the chemical and biological characteristics of surface waters, and include a fully equipped and operating installation for automated analysis of nitrogen and phosphorus species found in water and wastewater. Research vessels are available for sampling lakes and estuarine waters. Water samples can be processed in nearly all chemical and biological procedures associated with limnological studies. The UNC Wastewater Research Center has extensive space available for laboratory and pilot plant facilities.

Analog and digital computer facilities are available to faculty and students alike, as are shop facilities, including machine and instrument shops, woodworking shops, and electronic facilities. In addition, for the occasional investigation with special requirements, supplemental facilities are available at nearby universities, water and wastewater treatment plants, and organizations located in the nearby Research Triangle Park. Students wishing to undertake investigations in areas requiring expertise of faculty in other program areas or departments usually find it easy to make arrangements for appropriate guidance, and are encouraged by the WRE faculty to do so.

Under contracts with the Agency for International Development (AID) the department has carried out programs of assistance and research for developing countries on the environmental impact of development. Past programs were carried out with universities in Peru and Guatemala, and with representatives of thirty-five other countries throughout the world. The department currently conducts short courses for AID and the U.N. Industrial Development Organization for persons from developing countries in Central America and Africa.

PROGRAM REQUIREMENTS

All applicants must submit at least two letters of academic reference, a statement of career objectives, the aptitude portion of the Graduate Record Examinations, and transcripts from all institutions attended for eligibility for acceptance into departmental programs. The average grade point for new students in the WRE program in the fall of 1977 was 3.38; the average GRE score was 1240. Doctoral candidates are also required to submit a statement of research interests. For these applicants, admission also requires the sponsorship by a faculty member who agrees to serve as the student's program advisor.

For entrance into the M.S.E.E. program, a bachelor's degree in engineering from an ECPD accredited school or its foreign equivalent is required. An entrance requirement for the M.S.P.H. and M.S. programs is a bachelor's degree with a major in science (usually chemistry, biology, geology, or physics) or engineering. Students should have successfully completed at least forty semester hours of science or engineering including courses in physics, chemistry, biology, and college calculus. Admission to the Ph.D. program in WRE requires the successful completion of a master's degree in water resources engineering equivalent to that offered in this program.

The master's degrees require a minimum of eleven months of full-time study, although many master's candidates elect to continue for one or two additional semesters for enrichment and independent study beyond that attainable in the minimum program. Research and teaching assistants, who must render service obligations, proceed at a slower pace, normally completing the degree in twenty-one months. Ph.D. programs vary considerably in length, but most often extend two or three years past the master's degree.

The School of Public Health requires that M.S.P.H. candidates take a basic biostatistics course, a basic epidemiology course, and five departmental courses, or fifteen hours, in a field consistent with the program area. There are no core requirements or minimum departmental requirements for the M.S. and M.S.E.E. degrees. Programs of study for M.S. candidates are individually designed by the students in consultation with their faculty advisors. M.S.E.E. programs are determined by the minimum requirements of the ECPD. A minimum of thirty semester hours of credit is required for all master's degrees, and all candidates for the M.S.E.E. and M.S.P.H. degrees must select a topic and develop an acceptable technical report and register for ENVR 392 for at least three hours in the completion of the report. M.S. candidates are required to complete and defend a formal thesis. The technical report or thesis is presented at the time of the required oral comprehensive examination.

In addition to the school's degree requirements, the WRE program area requires that master's candidates take a minimum of one or two courses in each of five groups (detailed below). This arrangement provides latitude for the student and faculty advisor to plan a coherent program meeting the needs and desires of the individual. The master's program may be directed towards: the technical aspects of water supply and treatment; wastewater treatment and disposal and control of water pollution; planning, engineering, economic and administrative aspects of water resources development and management; or a combination of these approaches. The courses listed below are those which past students have most frequently elected in their programs. Descriptions are provided for those courses offered by the department; other approved courses are listed only. WRE students must take either ENVR 174 and 174L or ENVR 274 and 275.

Ph.D. programs are more varied because of research orientation and professional interests; programs of study are developed with the student and his/her committee to provide mastery in the chosen field. In addition to the major, doctoral candidates must have a supporting program of at least fifteen hours; a formal minor may be elected. Two courses in a research skill are required, and upon completion of the courses and preparation of the dissertation proposal, the candidate takes written and oral examinations before proceeding with major research activities. Registration in ENVR 394 for at least three credit hours is required in the completion of the dissertation.

CURRENT FACULTY, STUDENTS, GRADUATES

Six departmental faculty members carry out teaching and research responsibilities full-time, principally in support of the WRE program area. An additional six faculty members assist in the same manner on a part-time basis; several of these hold joint appointments with other departments in the university, and others are also engaged with environmental work in the private sector. All faculty members have the doctorate degree, with backgrounds and major research/teaching interests in a variety of areas within the water resources engineering field.

During the 1977-1978 term, fifteen students are seeking master's degrees in the WRE program, and three persons are pursuing the Ph.D. This enrollment has been fairly stable over the last ten years. One of the currently enrolled students is self-supporting; the remainder receive assistance from teaching and research assistantships, training grants and fellowships. The number of training grants available has substantially reduced in recent years.

During the 1976-1977 term one person received the Ph.D. in the WRE area, and eight persons received the M.S.E.E. During the following year, again one received the Ph.D., and fifteen received the M.S.E.E. One of those receiving the doctorate degree joined a consulting firm (engineering) upon graduation, while the other became employed by a large municipal environmental agency. Of the twenty-three M.S.E.E. graduates during these two years, two returned to their own countries (Malaysia and Pakistan), and the status of six is unknown, or they had not yet accepted positions at the time of the survey. Of the remainder, three accepted governmental positions, two are pursuing the Ph.D., one is with and industry, and nine are with engineering or research-oriented consulting firms.

PROGRAM PROJECTIONS

The Department of Environmental Sciences and Engineering is authorized only to admit as many students as it graduates. Therefore, the student enrollment in the department or in the specific programs is not expected to increase. The number of faculty members involved with the WRE program is also likely to remain stable.

Department faculty are considering the implementation of a new program area or area of emphasis; exactly how the new area will be incorporated into the curriculum is not yet determined. Under discussion is the development of research and course offerings on the effects of contaminants on human health. As envisioned, such a development would embrace such diverse disciplines as toxicology, medicine, pharmacology, and oncology, and would tackle subjects such as the relationship of water quality to cancer incidence and the effects of air discharges on upper respiratory ailments. A research committee has been formed to study the possibilities and make recommendations on the appropriate course of action for including this area in the department structure. In addition, funds are available for several new faculty members, and efforts are under way to secure new research grants in this area.

COURSE DESCRIPTION

Environmental Sciences (two courses from the following):

ENVR 122 Water Chemistry - Principles and applications of water chemistry. Consideration of equilibrium relationships in aqueous solutions such as natural waters. Proton transfer, solubility, complex formation, and redox reactions in natural waters. Thermodynamic background for equilibrium calculations, including free energy and activity relationships. Laboratory includes examples of titrimetric, colorimetric and electrometric methods of water analysis. (4 s.h.)

ENVR 131 Biology in Environmental Science - Biology, including principles of bio-chemistry, cell structure, classification, and ecology. Application to public health, including biology of waste treatment systems, biological indices of pollution, and water and airborne diseases. Laboratory emphasizes techniques utilized in measurement and control of environmental pollution. (3 s.h.)

ENVR 133 Environmental Biology - Environmental biology, with emphasis on ecological theory. Metabolism of individuals, reaction of populations and communities to environmental stress and ecosystem responses to perturbations. Laboratory emphasizes techniques widely used in aquatic biology and pollution control. (3 s.h.)

ENVR 134 Environmental Microbiology - Principles of general microbiology: an examination of the microbial world with emphasis on

ENVR 134 (Cont'd) - non-pathogenic bacteria, their cytology, growth, physiology, and significance in the environment with special attention given to treatment processes. (3 s.h.)

ENVR 181 Ground Water Hydrology - (2 s.h.)

ENVR 217 Systems Analysis in Environmental Planning - Systems approach and scientific method. Approaches to system design. Mathematical models. Production, benefit, loss and cost functions. Constrained optimization. Marginal analysis, Linear programming. Application of techniques to systems for the management of environmental quality. (3 s.h.)

ENVR 218 Environmental Systems Analysis I: Deterministic Models - Concepts of systems analysis. Modeling of environmental and urban systems. Linear algebra. Classical optimization techniques. Marginal analysis models in economics. Mathematical programming models. Linear, nonlinear, dynamic programming. (3 s.h.)

ENVR 219 Environmental Systems Analysis - Principles of model construction for complex urban and environmental resource systems. Review of models for urban and regional growth, water quality and quantity, air quality, and other environmental impacts. (3 s.h.)

ENVR 281 Topics in Advanced Hydrology - Urban hydrology, hydrological frequency analysis, extreme value theory, analysis of low flows, problem of storage synthetic hydrology. (3 s.h.)

Planning Design (two courses from the following):

ENVR 212 Planning and Development of Environmental Hygiene Programs - Concepts and techniques in planning, organization and management. Program development, decision making, methods for achieving administrative ends, field supervision, criteria establishment and evaluation procedures with reference to environmental programs. (3 s.h.)

ENVR 272 Technology of Engineered Water Systems - An examination of technology and planning techniques for water and wastewater systems including pumping stations, reservoirs, water distribution and wastewater collection networks. (3 s.h.)

ENVR 273 Water and Wastewater Treatment Plant Design - Application of theory of water and wastewater treatment to design of municipal treatment facilities. Principles of design and practices. (3 s.h.)

ENVR 277 Engineering Project Design - Decision model approach to project design. Demand analysis. Dynamic aspects: flexibility, sequence and timing. Water distribution systems, waste management systems. Application of analog and digital computers. (3 s.h.)

ENVR 278 Development of a Water Project - Analysis of a real water project including data collection, preliminary design, evaluation

ENVR 278 (Cont'd) - of engineering alternatives, and assessment of feasibility culminating in an engineering technical report. (3 s.h.)

ENVR 282 Public Investment Theory and Techniques - New methods of economic, engineering, and governmental analysis in public investment planning. Techniques include those for converting broad community objectives into specific criteria to design public projects, with emphasis on water resources. (3 s.h.)

ENVR 283 Natural Resource Law and Policy - The law of resource use and development, its administration and policies. Attention to water rights law, regulatory law and natural resource administration. Regulatory aspects of pollution control programs. (3 s.h.)

ENVR 284 Planning of Natural Resource and Environmental Systems - Application of systems analysis concepts and techniques to planning at the field level of land, water, and related environmental systems. Attention to urban needs. (3 s.h.)

ENVR 285 Special Project in Water Quality Planning - Project integrates the elements that affect water quality and the decision made in water management, e.g., water planning for a new city, industrial site developments. (3 s.h.)

Water Quality Management (one course from the following):

ENVR 132 Limnology and Water Pollution - Principles of limnology as they apply to water supply and waste disposal. Emphasis on the physical, chemical and biological factors of the aquatic environment to define the ecology of nonpolluted and polluted water. (3 s.h.)

ENVR 171 Water Quality Evaluation and Control - Characteristics of water as a resource. Water uses, trends. Water quality concepts, measurements, criteria, problems, pollutants. Water supply and wastewater treatment and disposal systems. Regulation of water quality standards. (3 s.h.)

ENVR 174 Water and Wastes Treatment Processes - Unit processes for water and wastewater treatment. Gas transfer, coagulation, disinfection, absorption, demineralization, sedimentation, filtration, aerobic and anaerobic biological treatment. (3 s.h.)

ENVR 174L Water and Wastes Treatment Processes Laboratory - Laboratory exercises to illustrate discussions of ENVR 174. (1 s.h.)

ENVR 176 Hydraulics and Hydrology - Principles of hydraulics and ground and surface water hydrology with emphasis on applications to design of water and wastewater systems. (3 s.h.)

ENVR 224 Chemical Modeling of Aquatic Systems - Application of aquatic chemistry to modeling water supplies, wastewaters, rivers, lakes, estuaries, and oceans. Stoichiometric, thermodynamic, and kinetic models are developed. (3 s.h.)

ENVR 271 Engineering Modeling of Aquatic Systems - Examination of selected physical, chemical and biological phenomena in natural aquatic systems. Mathematical modeling. (3 s.h.)

ENVR 274 Advanced Water and Wastes Treatment Processes I - Applications of chemical, physical, and biological principles to water and wastewater treatment. Equilibria, kinetics and reactor performance. Sedimentation, filtration, absorption, ion exchange, coagulation, precipitation. Lab exercises illustrate. (3 s.h.)

ENVR 275 Advanced Water and Wastes Treatment Processes II - Continuation of ENVR 274 with emphasis on wastewater treatment processes including aerobic and anaerobic biological treatment, gas transfer, solids handling, nutrient removal, membrane processes. Lab exercises are included. (3 s.h.)

ENVR 276 Industrial Water Quality Management - Water supply and wastes disposal problems of industries. Special water quality requirements and treatment methods. Nature of wastes, pollutional difficulties, methods of attacking problems (technical, administrative and regulatory aspects). Emphasis on diverse nature of these problems and methodology employed in their solution. (3 s.h.)

Master's Problem (three hours of the following):

ENVR 392 Problem or Research in Sanitary Engineering and Water Resources

Statistics (one course from the following):

BIOS 135 Probability and Statistics

BIOS 145 Principles of Experimental Analysis

BIOS 150 Elements of Probability and Statistical Inference

BIOS 151 Elements of Statistical Analysis

INSTITUTION: UNIVERSITY OF TENNESSEE

PROGRAM: Environmental Engineering (Water Pollution Control, Water Resources)

DEPARTMENT: Civil Engineering

DEGREE: Master of Science in Environmental Engineering (M.S.E.E.)
Master of Engineering in Environmental Engineering (M.E.E.E.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. W. L. Grecco
Department of Civil Engineering
Univeristy of Tennessee
Knoxville, Tennessee 37916
(615) 974-2503

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering began as an option in the Department of Civil Engineering in 1966. The Master of Science in Environmental Engineering is designed for students whose undergraduate background is other than engineering. The Master of Engineering is accredited by the Engineers' Council for Professional Development and therefore, requires students enrolled in this program to have undergraduate degrees in engineering. The Ph.D. is offered through civil engineering, and doctoral students may elect a major in environmental engineering.

This program conducts a large number of research activities with outside funding amounting to $846,300. The largest single contributor has been the Department of Energy (formerly ERDA) for a study entitled Environmental Aspects of Coal Production in the Appalachian Region. The U.S. Air Force is providing support for studies regarding stormwater runoff.

A substantial amount of specialized research equipment exists for students' use. For water quality analysis, are an atomic adsorption spectrophometer, gas and liquid chromatographs, a programmable data analyzer, a scanning ultra-violet spectrophometer, a total carbon analyzer, selective ion electrode meters, and additional turbidmeters, spectrophometers, fluorometers, and pH meters.

A large number of specialized instruments are available for laboratory experimentation in water and wastewater treatment research. The library services on the Knoxville campuses are supplied by three major libraries, including a science and engineering library. Combined they contain in excess of one and one-quarter million volumes.

Graduates of the programs in environmental engineering are qualified for employment as consultants, urban planners, hydrologists, systems analysts, construction managers, county planners, researchers, environmental and civil engineers, and environmental chemists.

PROGRAM REQUIREMENTS

For admission to the M.S.E.E. program, one must have graduated from a recognized undergraduate curriculum. It may be necessary for some articulation work to be done in preparation for certain of the technical courses. The graduate program leading to the M.E.E.E. degree is available to students who have undergraduate degrees from E.C.P.D. accredited Engineering programs. No admissions examinations are required.

All graduate students in environmental engineering must satisfy a primary core curriculum of fifteen quarter hours which consists of: ENVR 4030 or 4530 - Environmental Chemistry, ENVR 5230 or 5301 - Hydrology, ENVR 5561 (or 5501, 5502 or 5513) - Water Pollution Control, ENVR 5600 - Solid Wastes, ENVR 5710 - Air Pollution Control, ENVR 5590 - Seminar. Students must then select a secondary core of concentration from the following five topic areas: water pollution control, water resources, air quality and/or pollution control, environmental science, or environmental management.

The Water Pollution Control core requires the following courses: ENVR 4530 - Sanitary Engineering Laboratory, ENVR 5593 - Advanced Sanitary Engineering Laboratory, ENVR 5501 - Water and Wastewater Treatment Theory, ENVR 5513 - Advanced Water and Waste Treatment Systems, and ENVR 5551 - Water Quality Management. The Water Resources core requires ENVR 5230 - Surface Water Transport, ENVR 5301 Stormwater Modelling, ENVR 5310 - Groundwater Transport, and ENVR 5232 Sediment Transportation.

The program in Environmental Science requires: ENVR 4530 - Sanitary Engineering Laboratory, ENVR 5593 - Advanced Sanitary Engineering Laboratory, ENVR 5501 - Water and Wastewater Treatment Theory I or 5502 - Water and Wastewater Treatment Theory II or Advanced Water and Wastewater Systems, and ENVR 5530 - Natural System Behavior.

In Environmental Management students may opt to specialize in solid waste or in water. Solid waste specialty courses include: ENVR 5310 Groundwater Transport, ENVR 5610 - Solid Waste Collection, and ENVR 5400 - Environmental Systems Engineering. The water option calls for ENVR 4530 - Sanitary Engineering Laboratory, ENVR 5551 - Water Quality Management or 5301 - Stormwater Modelling I, and ENVR 5400 - Environmental Systems Management.

Students have the option of writing a thesis or not. Should one prefer to write a thesis, the student must present forty-five quarter hours of approved graduate courses. The major shall include a minimum of nine credits of thesis and eighteen of environmental engineering coursework. Those individuals who prefer to pursue the non-thesis option must present a minimum of forty-eight quarter hours of graduate courses. The major must include a minimum of twenty-seven quarter credits in the environmental engineering coursework and a three hour special project.

The graduate program leading to the degree of Doctor of Philosophy is offered through the Department of Civil Engineering. Major fields of study include structural engineering, transportation engineering, and environmental engineering. For the Ph.D. degree, one must complete a minimum of one hundred and eight credits beyond the baccalaureate degree, inclusive of credit earned toward a master's thesis. Of this, a minimum of thirty-six credits are applied to doctoral research and dissertation. At least thirty-six credits must be taken in civil or environmental engineering. Approximately thirty-six credits must be in supporting, related scientific and engineering fields. These usually include such disciplines as mechanics, chemistry, mathematics, microbiology, physics, and other engineering fields. To insure scientific literacy, a student may be required to know/learn one foreign language if it is considered crucial to one's research efforts. After completion of half of the coursework, each student must pass a preliminary examination. After completion of the dissertation and prior to graduation, candidates must pass a final examination administered by a faculty committee.

CURRENT FACULTY, STUDENTS, GRADUATES

Seven persons have full-time responsibility to environmental engineering. Their efforts are divided to permit approximately two-thirds of their effort to go to teaching, and the remaining one-third is devoted to research.

There are thirty-two people enrolled in both master's programs full-time and twenty-one part-time. Nearly all of these students are receiving financial assistance in the form of teaching and research assistantships. Approximately sixty percent of the students are Tennessee residents. Four of the doctoral students are pursuing environmental engineering majors.

During the academic year 1976-1977, three Ph.D. degrees and sixteen master's degrees were awarded. A follow-up study of twenty-nine recent graduates shows that twelve were employed in various government agencies, one is employed in a foreign government, three are pursuing Ph.D.'s, two are teaching, five are with consulting firms, and six with private industry.

PROGRAM PROJECTIONS

Environmental engineering is a program in the midst of tremendous growth. It is hoped that in two years a mining option with an emphasis on reclamation will be approved. This program will lead to a Bachelor of Science in Civil Engineering. In 1980-1985 it is anticipated that a Bachelor of Science in Environmental Engineering will expand the engineering offerings. In the long range plans is a B.S. in county engineering.

Two new programs have been approved at the graduate level. A Masters in Civil Engineering in Construction Management and a joint degree program in Transportation/Urban Planning are in the immediate departmental planning stage.

COURSE DESCRIPTION (SELECTED)

ENVR 5150 Water and Urban Welfare - Evaluation of social, environmental and economic impact on planning and management of urban water systems. Procedures for analyzing multi-objective policy alternatives with selected case studies. (3 q.h.)

ENVR 5210 Advanced Water Resources Engineering - Complex problems encountered in water resources engineering. Analysis of problems preliminary to design of complex water resources structures. (3 q.h.)

ENVR 5232 Sediment Transportation - Sediment properties and their measurements; bed loads and suspended load movement; erosion, scour, transportation and deposition of sediments by flowing water; silting of reservoirs and related topics. (3 q.h.)

ENVR 5234 Flood Damage Reduction - Survey of national, regional, and local flood problems; hydrologic design criteria, traditional flood control measures; and other flood damage reduction elements; interdisciplinary approach in floodplain management. (3 q.h.)

ENVR 5263 Remote Sensing Data Analysis and Interpretation - Manual and automatic methods of data analysis and interpretation; use of automatic data processing equipment. (3 q.h.)

ENVR 5302 Stormwater Modelling II - Continuous streamflow records are interpreted using methods of stochastic hydrology. Hydrologic design of water resources systems using streamflow techniques. (3 q.h.)

ENVR 5310 Groundwater Transport Processes - Dynamics of flow in porous media with emphasis on physical processes important in subsurface hydrology. Hydrodynamic dispersion, anisotrophy, layered soils, and unsaturated flow phenomena. Analytical solutions of flow equations. Dupuit approximation, analog and numerical methods, Hele-Shaw, and graphical solutions. (3 q.h.)

ENVR 5502 Water and Wastewater Treatment Theory II - Theory of physical, chemical and biological processes employed in sanitary engineering. (3 q.h.)

ENVR 5513 Advanced Water and Waste Treatment Systems - Theory, operation, and use of advanced water and waste treatment systems. Emphasis on systems used for wastewater reclamation. (3 q.h.)

ENVR 5530 Environmental Engineering and Natural System Behavior - Relationship between environmental engineering and natural system behavior; focus on eutrophication and the limiting nutrient concept in relation to research and its translation into law and practice. (3 q.h.)

ENVR 5551 Water Quality Management - Water quality control objectives, methods and philosophies; water quality criteria; regulatory standards; economic considerations. (3 q.h.)

ENVR 5561 Aquatic Environment Pollution - A study of effects resulting from agricultural, municipal, and industrial pollution upon physical, chemical, and biological characteristics of natural water. (3 q.h.)

ENVR 5582 Microbiology for Sanitary Engineers - A study of microorganisms and microbiological processes which are significant in sanitary engineering, including basic microbiology, detection and identification, enzymes, metabolic reactions, energy transfer, synthesis and growth; aerobic and anaerobic biological treatment processes. (3 q.h.)

ENVR 5593 Advanced Sanitary Engineering Laboratory - Advanced laboratory techniques used in analysis of water and wastewater. Application of modern instrumental procedures for physical, chemical, and biological analysis. (3 q.h.)

ENVR 5600 Solid Wastes - Magnitude and characteristics of the solid waste problem; methods of collection and disposal, including sanitary landfill, incineration, composting, proposed new technologies, and recycling. (3 q.h.)

ENVR 5620 Solid Waste Collection Systems - Analysis and designs of collection systems, methods of collection, crew size, routing of vehicles, efficiency of collection systems, and management planning. (3 q.h.)

ENVR 5700 Planning and Air Pollution Control - Relationship between air pollution, area development, and urban growth. Social, economic, and political processes involved in air pollution control. (3 q.h.)

ENVR 5730 Air Pollution Control Device Design - Design and evaluation of systems used to control emission of gaseous and particle air pollutants. Comprehensive design of specific devices and systems. (3 q.h.)

ENVR 5760 Diffusion in the Atmosphere - Movement and dilution of natural or man-made material released into the atmosphere. Basic theory is developed and observations reviewd. Specific topics include the rise of bouyant plumes, the relation between Eulerian and Lagrangian spectra, the differences between instantaneous and continuous sources, diffusion in a zone of wind shear and diffusion from urban area sources. (3 q.h.)

ENVR 6500 Industrial Waste Treatability and Process Control - Sources and characteristics of industrial wastes; treatment alternatives related to ultimate disposal, treatability and process control studies of physical, chemical, and biological processes using laboratory bench-scale treatment units. (6 q.h.)

INSTITUTION: UNIVERSITY OF TEXAS, AUSTIN

PROGRAM: Environmental Health Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science (M.S.), Doctor of Philosophy (Ph.D.) in Environmental Health Engineering

CONTACT:
Dr. E. Gus Fruh
Director, Environmental Health
Engineering Laboratories
University of Texas, Austin
Austin, Texas 78712
(512) 471-5602

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

In 1965 the University of Texas at Austin, initiated a new program within the environmental health engineering options, which responded to the national concerns regarding air pollution control and abatement. The major emphasis of the environmental health engineering programs to 1965 had been in the fields of water, wastewater and related areas. Today, a strong program is still conducted in these areas, but is herewithin reported in the volumes pertinent to potable water and wastewater.

The graduate program which emphasizes air quality studies is a flexible curriculum. Students as well as faculty have a multitude of research opportunities available to them at the University of Texas. Extensive research and laboratory facilities are an integral part of the university structure. Located on the main campus are facilities for air pollution research and instruction. The air pollution research both on and off the campus, emphasizes engineering solutions to specific municipal and industrial problems throughout the southwestern United States. Currently, activities include the design of an isokinetic sampling probe, evaluation of a high volume sampling technique, particulate coagulation in automobile exhaust, development of methodologies to evaluate the air pollution potential of an urban area, and improving the particulate removal at coal burning power plants.

These graduate programs at the University of Texas, while strongly research oriented, also prepare students within a strong curriculum sequence which includes engineering design and natural science. These programs focuses on preparing professional, well-equipped persons to meet air quality related environmental problems, and on preparing practical engineering and alternative solutions. The programs lead to the Master of Science and the Doctor of Philosophy degrees.

PROGRAM REQUIREMENTS

Admission to the University of Texas-Austin graduate programs is dependent upon acceptance by the University and by the Committee on Graduate Studies. The Graduate Record Examination scores as well as academic background are reviewed and evaluated pursuant to the criteria of the Committee.

Normally the basic requirements for the Master of Science degree include completion of 30 semester hours of course work, 15 to 24 (including thesis) must be in the major program. A minor is required and includes at least six semester hours of supporting subjects or subjects outside the major. Individual arrangements may be made so that a thesis is not required. Other activities as specified by the Dean must be completed satisfactorally in this event. All course work, however, must be logically related and the approval of the graduate advisor is necessary.

The requirements for completion of the Doctor of Philosophy degree are individually developed in accordance with the student's doctoral committee. A language requirement is necessary, as well as a comprehensive examination in the major area, and a defense of the dissertation.

CURRENT FACULTY, STUDENTS, GRADUATES

At present, there are nine faculty members actively participating in these graduate programs. Seven are full-time and two are part-time.

Students enrolled in the air pollution section of the environmental health engineering programs total 15. Of the 15 total, 12 are master's students and include seven full-time and five part-time. At the doctoral level, there are three part-time students. Approximately four annually are awarded the Master of Science and the Doctor of Philosophy degrees.

Approximately 20% of those students receiving the Master of Science degree, historically continue their education in pursuit of the doctoral degree. About one-third of the continuing students choose the University of Texas for their doctoral studies.

Financial assistance is available in several forms including research and teaching assistantships and fellowships.

PROGRAM PROJECTIONS

The air component of the University of Texas environmental health engineering program is anticipated to expand over the next few years. In response to increased needs for well-trained engineering personnel in the field of air pollution control and abatement, the student population will increase. Pursuant to these expansion plans, one engineer with air quality expertise is proposed for addition to the current faculty. No new degree programs are planned for the near future.

COURSE DESCRIPTION (selected)

CE 390K Air and Water Analysis - Fundamental treatment of environmetal, Chemical, and biological principles. (3 s.h.)

CE 396L1 Air Pollution Evaluation - Classification, transport, transformation, effects, sampling and analysis of particulate and gaseous air pollutants in source gases and ambient air. (3 s.h.)

CE 396L2 Particulate Air Pollution Control - Principles, design and applications of inertial, scrubbing, filtration and electrostatic precipitation for particulate emission control. (3 s.h.)

CE 396L3 Gaseous Air Pollution Control - Principles, design and applications of absorption, adsorption, condensation and incineration systems for gaseous emission control. (3 s.h.)

CE 396L4 Air Pollution Control Unit Operations - Laboratory and field studies of the principles and operation of gaseous and particulate control equipment and associated source monitoring equipment.(3 s.h.)

CE 396L5 Air Quality Management - Integration of engineering, legal and economic aspects of air pollution control and air quality maintenance programs. (3 s.h.)

CE 384M Industrial Hygiene and Toxicology - Mechanism by which toxic gases, vapors and dusts produce diseases in experimental animals and man with toxic substance control in specific processes. (3 s.h.)

CE 388M Radiological Health Principles - Ionizing and electromagnetic radiation phenomena with shielding, identification dosimetry, detection, decontamination, radioactive waste management and atmospheric release containment technology. (3 s.h.)

CE 390L Environmental Analysis - Application of instrumental analyses to measurement of organic and inorganic gaseous and particulate materials in air, water and land environments. (3 s.h.)

CE 396M12 Air Pollution Meteorology - Meteorological factors relating to forecasting air pollution potential including atmospheric dispersion models for calculating air pollutant concentrations from point line and area sources. (3 s.h.)

CE 396M13 Turbulent Diffusion in the Environment - Turbulent diffusion processes of heat, mass and momentum transfer in the atmosphere affecting the dispersion and dilution of air pollutants. (3 s.h.)

ChE 384 Physics and Chemistry of Aerosols - Physical and chemical phenomena of aerosol, formation, transport, and reactions in the atmosphere. (3 s.h.)

INSTITUTION: UNIVERSITY OF TEXAS, AUSTIN

PROGRAM: Water Resources Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science (M.S.), Doctor of Philosophy (Ph.D.) in Environmental Health Engineering

CONTACT: Dr. E. Gus Fruh
Director, Environmental Health
Engineering Laboratories
University of Texas, Austin
Austin, Texas 78712
(512) 471-5602

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The environmental health and water resources engineering programs were instituted at the University of Texas, Austin, in 1957. Since that time, the program has undergone substantial changes in curriculum offerings and program sequence. Although students of these programs are prepared with broad-based backgrounds to meet a wide variety of environmental problems, the major emphasis is on water resources, water pollution control, and other areas related to water and wastewater.

These graduate level programs are oriented within strong curricula which include engineering design and natural science. These programs focus on preparing professional well-equipped persons to meet water related environmental problems and to prepare practical engineering alternatives and solutions.

The University of Texas, Austin is endowed with a wide variety of well-equipped laboratories and research facilities. Students and faculty have a wide range of research opportunities. The Center for Research in Water Resources is located in a laboratory-office complex located approximately seven miles from the main campus. The Center provides a multitude of research work which include several disciplines. These laboratories are equipped with large-scale pilot plants, model river flumes, model impoundments and various analytical equipment. Current activities include the development of design guidelines for chemical, biological and physical treatment of wastewaters; filtration of oil coated solids; removal of heavy metals; denitrification in deep filters; and the effects of pure oxygen on biological treatment systems. Other areas of investigation include the use of biologically treated municipal wastewater as a source of cooling water for electrical power plants, and virus enumeration and inactivation in activated sludge, waste stabilization pond and soil systems, and the effects of heated power plant discharges on stratified reservoirs.

Graduate studies in these programs involves a balanced combination of course work, seminars and research activities. These programs of study lead to the Master of Science and to the Doctor of Philosophy degrees.

PROGRAM REQUIREMENTS

Admission to the University of Texas, Austin graduate programs is dependent upon acceptance by the University and by the Committee on Graduate Studies. The Graduate Record Examination scores as well as academic background are reviewed and evaluated pursuant to the criteria of the Committee.

Normally the basic requirements for the Master of Science degree include completion of 30 semester hours of course work, 15 to 24 (including thesis) must be in the major program. A minor is required and includes at least six semester hours of supporting subjects or subjects outside the major. Individual arrangements may be made so that a thesis is not required. Other activities as specified by the Dean must be completed satisfactorally in this event. All course work, however, must be logically related and the approval of the graduate advisor is necessary.

The requirements for completion of the Doctor of Philosophy degree are individually developed in accordance with the student's doctoral committee. A language requirement is necessary, as well as a comprehensive examination in the major area, and a defense of the dissertation.

CURRENT FACULTY, STUDENTS, GRADUATES

At present, there are nine faculty members actively participating in these graduate programs. Seven are full-time and two are part-time.

Students currently enrolled in the environmental health and water resources engineering programs at both the master's and at the doctoral level total approximately 78. They are distributed according to the following:

Program		Water Resources Engineering	Environmental Health Engineering-Water
M.S.	Full-time	7	32
	Part-time	4	15
Ph.D.	Full-time	5	10
	Part-time	2	3
Total		18	60

Of the total 78 students, 58 are master's level students and 20 are doctoral students. Approximately 33% of the master's students are part-time while 25% of the doctoral students are part-time. Overall, approximately 10% are female and 90% are male.

Graduates at both levels approximate 25 to 35 annually. The majority of these graduates are those students receiving the Master of Science degree.

PROGRAM PROJECTIONS

Significant growth in the student population or in the faculty is not anticipated over the next few years. The program have stabilied and future emphasis will be placed on up-grading the current course offerings.

COURSE DESCRIPTION (selected)

CE 385K Water Quality - Analysis of water quality in natural systems and of effects of wastewater discharges. Section 1: Stream, impoundment, and estuarine analysis I. Water Quality modeling. Section 2: Stream, impoundment, and estuarine analysis II. Methods for analysis of water quality problems. (3 s.h.)

CE 385L Water and Wastewater Treatment - Principles of treatment of domestic and industrial water, wastewater, and sludges. (3 s.h.)

CE 385M Unit Operations in Water and Wastewater Treatment - Physical, chemical, and biological unit operations for water treatment and pollution control problems. (3 s.h.)

CE 385N Industrial Wastewater Treatment - Industrial wastewater characteristics; methods of in-plant control; application of various biological, chemical, and physical processes. (3 s.h.)

CE 386M Water Resources: Design of Water and Wastewater Systems - Problems in the design of water and wastewater treatment plants.(3 s.h.)

CE 388M Radiological Health - Principles; analysis of radiation hazards; unit operations and processes used in handling radioactive wastes. (3 s.h.)

CE 388N Solid Waste Engineering - Biological, chemical, and physical principles and integrated systems applicable to treatment and disposal. (3 s.h.)

CE 388P Environmental Engineering of Energy Systems - Identification of environmental issues and evaluation of standards associated with power plant siting and transmission systems. (3 s.h.)

CE 390M Water Quality Management - A consideration of the technical, scientific, legal, and socioeconomic aspects of water quality management. (3 s.h.)

CE 397 Special Studies in Civil Engineering - Section 23: Water resources planning and management. Quantity and quality considerations. Section 24: Water resources systems analysis. Policy and legal aspects at the federal, state, and local levels. Section 53: Water quality management: Streams and lakes. Advanced analysis, synthesis, and design of engineering solutions. Section 54: Water (3 s.h.)

CE 397 (cont'd) - pollution control. The application and evaluation of new concepts in water pollution abatement and waste-water treatment facilities. Section 55: Solid wastes disposal. Analysis and synthesis of new engineering design and management schemes for integrated waste control systems. (3 s.h.)

INSTITUTION: UNIVERSITY OF WISCONSIN-MADISON

PROGRAM: Water Resources Management, Environmental Monitoring, Land Resources

DEPARTMENT: Institute for Environmental Studies

DEGREE: Master of Science in Water Resources Management (M.S.)
Master of Science and Doctorate in Environmental Monitoring (M.S.) (Ph.D)
Master of Science and Doctorate in Land Resources (M.S.) (Ph.D.)

CONTACT: Dr. Reid A. Bryson, Director/Dr. Arthur B. Sacks
Institute for Environmental Studies
1339 Meterology & Space Science Building
1225 West Dayton Street

Coordinator of Academic Program
Institute for Environmental Studies
70 Science Hall
550 North Park Street

University of Wisconsin-Madison
Madison, Wisconsin 53706

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Institute for Environmental Studies offers interdisciplinary education for undergraduate and graduate students. Some undergraduates in the College of Letters and Science are developing environmental studies majors in consultation with the Institute of Environmental Studies (IES) through the Individual Major Program. Degrees in Environmental Studies, per se, are not available at the University of Wisconsin-Madison at this time. However, students may get involved in this area through 1) association with IES, 2) a number of cross-departmental programs, and 3) a wide variety of departments currently emphasizing environmental studies.

IES administers three graduate programs, and M.S. in Water Resources Management, and M.S. and Ph.D. degrees with major in Land Resources and Environmental Monitoring. Possibilities for a graduate program in Environmental Systems Analysis are currently being explored with the Graduate School and the University Administration.

PROGRAM REQUIREMENTS

An individual with an undergraduate or graduate degree in the biological sciences, earth sciences, economics, engineering, law, urban and regional planning, landscape architecture, mathematics, journalism, political science, or other suitable fields may apply for admission to the Water Resources Management Program. The general admission requirements of the Graduate School apply. Two options are available. Most students elect the 45-credit option; however, individuals with three or more years of professional experience and/or those with advanced degrees may elect the 30-credit option. Double masters programs can be arranged with the consent of appropriate departments. Basic requirements for the 45-credit hour option include a minimum of 30 credits in the core curriculum plus a minimum of 15 credits within an area specialty. This option generally requires four semesters and one summer session. In the second option, a minimum of 30 credits in the core curriculum is required. The choice of courses should supplement relevant experience. This option generally requires two semesters and one summer session.

Students should enter the interdisciplinary Environmental Monitoring program with depth in a discipline. Normally this discipline will be in one of the natural science or engineering fields such as botany, chemistry, civil and environmental engineering, computer science, electrical engineering, forestry, geography, geology and geophysics, meteorology, physics, soil science, or zoology. Physical planning and/or design fields such as landscape architecture or urban and regional planning are also appropriate disciplines. Applicants presenting other backgrounds may be considered for admission with deficiencies. As part of their applications, students must submit a statement indicating the nature of their particular interdisciplinary program interests and three letters of recommendation. All applicants must meet the general requirements of the Graduate School.

A minimum of 30 credits of graduate study is required for the M.S. degree. Of these 30, students must meet Depth, Breadth, Interdisciplinary Synthesis, Thesis, and other requirements. Similar requirements apply for the Ph.D. degree.

The Land Resources Program is most appropriate for individuals with undergraduate training or experience in resource planning or management; natural or earth sciences; engineering or design; land institutions; or the economics, history or geography of land. Applicants with backgrounds in areas other than these, but with a strong interest in land resource problems, may enter the program with special permission. The general regulations of the Graduate School apply to all admission. In addition, persons applying to this degree must submit a statement indicating the nature of their specific program interests as well as three letters of recommendation.

The M.S. requires a minimum of 30 credits; the Ph.D. requires a minimum of 64 credits. The degree format is structured to foster both depth and breadth in knowledge related to land resource problems. A student may draw freely from the course offerings of several departments, but an individual's program as a whole must be directed toward specific goals with the student's research related to the same goals as his/her course work selections. Candidates for the M.S. degree must complete a thesis or a supervised research paper in lieu of a thesis. Ph.D. candidates are required to submit a research thesis.

CURRENT FACULTY, STUDENTS, GRADUATES

A total of 52 faculty comprise the institute staff. Most are departmentally based and contribute only part-time to the Institute.

There are 72 students in the Water Resources Management M.S. program; seven M.S. and seven Ph.D. candidates in the Environmental Monitoring program; and 21 M.S. and 14 Ph.D. students in the Land Resources program.

Graduates of the Water Resources program have had no difficulty finding employment (approximately 20 are graduated each year). All are employed in their field; 50 percent in the private sector, 50 percent in government. The Land Resources program was begun in 1976, and the Environmental Monitoring program in 1977.

PROGRAM PROJECTIONS

The IES offerings may be expanded to include toxicology, environmental planning, and energy in the future.

ADDITIONAL INFORMATION

The Institute offers three-week intersession courses for undergraduates. Workshops and seminars in water quality and mining and oil shale development have been presented.

COURSE DESCRIPTION (A partial listing)

101 Forum on the Environment - Lectures, discussions, and field study of environmental problems. Philosophical, political, and social implications are discussed, as well as technical considerations. (3 s.h.)

121 Atmospheric Environment of Man - The interactions of man and his societies with the atmospheric environment. (2 s.h.)

122 Climatic Environments of the Past - Climatic history of the last 10,000 years; the environmental background of history. (2 s.h.)

127 Physical Systems of the Environment - Climatic regimes, land forms, soils, water and life forms at the earth's surface in terms of energy-transforming processes, locational patterns, and changes through time. (5 s.h.)

300 Environmental Management - An integrated, interdisciplinary survey course to give basic understanding of current issues calling for intelligent citizen action. Resource management science, technology, history, organization, and philosophy. (3 s.h.)

321 Environmental Pollution Control for Non-Engineers - An introduction to air, land, and water pollution control technology. Intended to convey the engineering approach to pollution control technology. Intended to convey the engineering approach to pollution problems, solutions, and to define the technological and sociological interface in arriving at these solution. (3 s.h.)

323 Environmental Microbiology - Relationships of microorganisms to their environment and to other organism. The course will cover soil, aquatic, and geomicrobiology, and microbial symbioses. (3 s.h.)

324 Soils and Environmental Pollution - Interaction of soils with environmental contaminants and the role of soils in pollution control. (3 s.h.)

336 Our Hazardous Environment - An analysis of the unexpected: Hazardous elements of our physical environment (such as hurricanes, tornadoes, floods, earthquakes, etc.)--their physical characteristics, regional distribution, economic aspects, and human adjustments. (3 s.h.)

371 Nuclear Energy and the Environment - Fission and fusion processes, nuclear reactors, power plants, radioactivity, biological effects, radiation and thermal releases, governmental regulations' impact on society. (3 s.h.)

400 Environmental Core Studies - Lecture, discussion and field trips for intensive, interdisciplinary study of environmental topics. Technical, political, economic, social, and philosophical implication are included. Past topics include: Alternative Sources of Energy, Predicting Food Supplies, Energy Conservation, Issues in Human Population Control, Environmental Law and Decisionmaking and Environmental Systems Analysis. (2-4 s.h.)

440 Environmental Decisionmaking - The course will examine the environmental decision process within a broad cultural and historical perspective. Emphasis will be upon the socio-politico-economic forces that influence decision-making. (3 s.h.)

441 Environmental Ethics - Treatment of ethical theories with an eye to their adequacy or inadequacy in handling such wrongs as harm to the land, to posterity, to endangered species. and to the ecosystem itself; exploration of the view that not all moral wrongs are based directly or even indirectly upon harm to human beings; critical treatment of possible grounds for that view; inquiry into the notion of the quality of life and the ethics of what have been termed "overcrowded lifeboat situations." (3 s.h.)

506 Modeling and Analysis of Environmental Systems - An upper-level course in systems modeling intended for students in the physical sciences who are interested in applications to environmental problems, and for students in life sciences who are interested in system methods. (3 s.h.)

516 Ocean Environment - A survey of sea and fresh water environments (other than water motion); includes applied marine biology, water chemistry, and geological oceanography. (1-3 s.h.)

535 Atmospheric Dispersion and Air Pollution - The physical principles of transport processes in the atmosphere, and how the processes vary with time and place, resulting in high levels of local and regional pollutant concentration. The environmental implications of air pollution and control strategies for preservation of atmospheric quality. (3 s.h.)

552 Remote Sensing of the Environment - Emphasis on airborne sensing. Characteristics and uses of photography, electro-optical scanners, multispectral imagery, radar imagery, passive microwave sensing, and other sensors. Applications to air and water quality studies, geography and geology, highway and traffic engineering, soils mapping and evaluation, urban and regional planning, and other fields. (3 s.h.)

666 Environmental Monitoring System Study - Interdisciplinary approach to formulation and solution of major environmental problems; problem definition including related issues; alternative solutions and detailed design. (3 s.h.)

719 Water Resources Management Practicum - An interdisciplinary team of students and staff work closely with agency personnel, citizen groups, and/or private sector representatives on the analysis of a contemporary, problem-oriented water resource issue. Physical, biological, economic and social aspects of the issue are integrated into the analysis through the use of small teams and group discussion. Course involves extensive interviewing and literature review. (6 s.h.)

761 Colloquium in Air Pollution - Discussion of current research at the University on emission sources, engineering control of air pollutants, atmospheric modeling, health and plant effects. (1 s.h.)

765 Environmental Monitoring Practicum I - An interdisciplinary workshop that will investigate "real world" environmental problems. Environmental monitoring will be one of the sources of data required for investigation. The topic will be chosen each year by the faculty and students in the Environmental Monitoring Degree Program. The course is intended to be an example of interdisciplinary synthesis and analysis. A comprehensive report will be prepared by the students enrolled. (3 s.h.)

920 Environmental Monitoring and Data Acquisition Seminar - Selected topics dealing with environmental monitoring and data acquisition, with emphasis on remote sensing of the environment. (1 s.h.)

935 Seminar in Air Resources Management - An interdisciplinary investigation seminar focused on a specific current problem in air resource management with staff and students contributing to the development of the issues, methodology, data, analysis, and policy formulation. (2 s.h.)

966 Seminar in Water Resources Planning - Governmental and legal aspects of water resources management; problems of public policy for control and use of water and related land resources. (2-3 s.h.)

INSTITUTION: VANDERBILT UNIVERSITY

PROGRAM: Environmental and Water Resources Engineering/ Water and Wastewater Treatment/Water Resources

DEPARTMENT: Environmental Engineering and Policy Management

DEGREE: Master of Science (M.S.)
Master of Engineering (M.Eng.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Karl B. Schnelle, Jr., Chairman
Dept. of Environmental Engineering and Policy Management
Vanderbilt University
Nashville, Tennessee 37240
(615) 322-4757

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering began at Vanderbilt in 1962. Five years later Sanitary and Water and Wastewater Resource Engineering became a department. After six major departmental changes, the name became Environmental Engineering and Policy Management.

The primary focus of advanced level studies in this department is on the development of modern quantitative techniques and their application to practical problems encountered in the field of environmental pollution and control. Advanced analytical, numerical, and statistical methods are combined with elements of water quality, systems analysis, hydraulics, biology and chemistry to provide the necessary background for conducting significant design, planning, and research in the environmental area.

Current research projects include studies on thermal pollution, waste assimilation, stratified flow dynamics, industrial waste treatment, biological waste treatment, effects of pollutants on water quality in reservoirs, and methods of environmental education for the public. Students are all required to use computers in course work and are encouraged to use computer analyses in their research projects. Research needs of the program are served by the Joint University Libraries System which holds more than 1.25 million volumes and a catalogue of 6,373 periodicals. Complete facilities are available for water analysis, including atomic adsorption, spectrophotometry, and gamma-ray spectrometry. Extensive facilities for water and waste treatment pilot plants and hydraulic research (including a 60-foot flume) are available. In addition a partial analytical equipment inventory includes a gas chromatograph, ultraviolet and infra-red spectrophotometers, Zeta meter, and a recording polarograph.

PROGRAM REQUIREMENTS

A bachelor's degree in engineering or science, completed with a 3.0 (on a 4.0 scale) grade average is required for admission to the Department of Environmental Engineering and Policy Management. Competence in given areas is a key factor, not necessarily how many courses one may have taken.

The normal requirements for an M.S. degree include the completion, with a 'B' average, of at least twenty-four semester hours of formal course work, and the submission of a thesis. Students have the option in this program of following a non-thesis plan which requires thirty semester hours of graduate study, presentation of an oral report to a research seminar on a subject in the field of investigation, and submission of a written account of this work to the supervisory professor.

An advanced professional degree which is especially designed for engineering practitioners who prefer to continue working while engaged in graduate study is available. Students may complete one course at a time and have seven years to finish the Master of Engineering degree. Thirty semester hours, including twelve hours in the candidate's chosen program, are required. The remaining hours may be approved courses in other programs. At least twelve hours must be chosen from courses designated as Engineering Graduate Professional Courses.

Five options for specialization exist. They are: Water and Wastewater Treatment Engineering, Water Resources, Air Resources, Solid Waste, and Environmental Science. A core curriculum for each has been developed to guide the students through their respective programs. Should the curricula not be pursuant to the needs of a student, then together with his/her advisor, a request for variance may be filed with the director of the program. This request should be made early in the course of a student's study.

The Water and Wastewater Treatment Engineering option requires the following courses: EWRE 271 - Environmental Chemistry, EWRE 272-Microbiology of Water, Wastewater, and Air, EWRE 318 - Systems Analysis for Environmental Engineers, EWRE 321 - Water Treatment Theory and Practice, EWRE 300 - Water Quality Management, and MATH 252 - Statistical Analysis for Environmental Scientists and Engineers. The Water Resources option requires the following: EWRE 277-Open Channel Hydraulics, EWRE 278 - Hydrology, EWRE 318 - Systems Analysis for Environmental Engineers, EWRE 345 - Water Resources Engineering, EWRE 300 - Water Quality Management, MATH 252 - Statistical Analysis for Environmental Scientists and Engineers, and EWRE 279 - Economics and Law of Air and Water Resources.

Individuals wishing to pursue the Doctor of Philosophy degree will design programs of study, in consultation with their advisors, which are specific to their educational objectives. The doctoral program normally takes two and one-half to three years of work beyond the M.S. degree level. The first two years are generally devoted to course work and to preparation for the general examination which admits one to doctoral candidacy. Most students require one year to complete the dissertation, work on which ensues after the second year. The final public oral examination is held after the dissertation is submitted, and consists of a thesis defense and an examination of the student's expertise in his/her field of study.

CURRENT FACULTY, STUDENTS, GRADUATES

Including the department chairman, there are the equivalent of nine full-time faculty whose primary focus is on teaching. During 1977, there were six persons enrolled in the Master of Engineering program, sixteen in the Master of Science program, and ten seeking the Ph.D. degree.

Approximately 50 percent of the graduate students are receiving financial assistance. Such aid is available to all M.S. and Ph.D. candidates in amounts up to $4,000 per year plus tuition. The EWRE program has a variety of fellowships and assistantships available. Students who are receiving support from fellowships or traineeships, or from research or teaching assistantships may take normal course loads.

While precise figures were not available, it is estimated that 40 percent of the graduates from the past three years have been employed by the Environmental Protection Agency, 25 percent have been employed by state agencies, 10 percent by other federal agencies, and 25 percent by private consulting firms and industry.

PROGRAM PROJECTIONS

Since its inception, this department has undergone six major upheavals. The result of that constant flux is that now officials are striving to achieve departmental stability.

There is currently a moderate recruitment effort being made. Officials would like to see the master's enrollment level reach forty.

COURSE DESCRIPTION

Math 252 Statistical Analysis for Environmental Scientists and Engineers - Frequency distributions, central tendency, dispersion, classical distributions, comparison of means and variances, correlation, linear and nonlinear regression. Applications to environmental studies. (3 s.h.)

EWRE 222 Methods of Scientific Research - Scientific investigation as illustrated by study of case histories. Preparation for research, hypotheses in science, planning experimentation, the role of chance in scientific discovery, intuition in science, reasoning in science; difficulties in research, style and taste in research, EWRE 222 (Cont'd) - strategy in research, scientific knowledge, social values. (2 s.h.)

EWRE 270 Public Health Engineering - Principles of public health engineering, study of vector control, communicable disease control, milk and food sanitation, refuse disposal, and general environmental sanitation. (2 s.h.)

EWRE 271 Environmental Chemistry - Theoretical aspects of physical, organic, and inorganic chemistry as applied to environmental engineering problems. (3 s.h.)

EWRE 272 Microbiology of Water, Waste Water, and Air - Principles of biology and their application to environmental science with emphasis on microbiology of air, water, sewage, and industrial wastes. (4 s.h.)

EWRE 273 Environmental Chemistry Laboratory - Chemical analysis of water and waste water and the laboratory control of water purification and waste water treatment processes. (3 s.h.)

EWRE 277 Open Channel Hydraulics - Resistance in open channels. Hydraulic design of channels. Steady, non-uniform flow (back water curves). Unsteady, non-uniform flows. Methods of characteristics. Numerical solutions for unsteady flows. (3 s.h.)

EWRE 278 Hydrology - Hydrologic cycle, study of precipitation, evapotranspiration, stream flow, flood flow, ground water, flood routing, snowmelt, and hydrometeorology. (3 s.h.)

EWRE 279 Economics and Law of Air and Water Resources - Economics of air and water resource conservation and development, water rights, public policy and laws relating to air and water resources. (3 s.h.)

EWRE 280 Atmospheric Pollution - Fundamentals of atmospheric pollution and control. Sources and nature of gaseous and particulate air pollutants, relation of meteorological conditions to their dispersal, and their effects on health and materials are discussed along with administration, standards, and control of air pollution. (3 s.h.)

EWRE 295 Solid Waste Management - Introduction to problem of solid waste management; types and quantities of wastes, collection and transportation of wastes; composting, landfill, incineration; recycling of wastes and product recovery; resource management system. (3 s.h.)

EWRE 300 Water Quality Management - Effects of physical, chemical, biological, and physiological pollutants in streams, reservoirs, and estuaries; fate of pollutants in the environment; water quality criteria; water quality management methodology. Biological aspects of water quality control. (3 s.h.)

EWRE 318 Systems Analysis for Environmental Engineering - Differential equation models derived from basic principles of heat, mass and momentum transport, reaction kinetics, and mixing and blending. Digital and analog computers are used to obtain solutions to equations. Application of differential equations to problems such as the dispersion of pollutants in rivers. (3 s.h.)

EWRE 321 Water Treatment Theory and Practice - Drinking water standards, advanced study of theory of operation of water treatment operations and processes, relation of theory and design practice, analysis and design of water treatment units. (3 s.h.)

EWRE 322 Waste Treatment Theory and Practice - Theory and practice of biological waste treatment. Treatment of municipal and industrial wastewaters by biological processes. Design and operation of biological waste treatment facilities. Principles and practice of sludge dewatering and disposal. Advanced wastewater treatment. Analysis and design of wastewater treatment systems. (3 s.h.)

EWRE 333 Air Pollution Control - Design and operation of air pollution control equipment. Methods of application of control in various industries. (3 s.h.)

EWRE 334 Air Pollution Meteorology - Basic meteorology of urban atmosphere and effects on air pollution. Structure and properties of atmospheric boundary layer; atmospheric turbulence and diffusion; isolated point, line volume, and area sources; buoyant plume rise; building effects; urban climatology and meteorology; urban air pollution models. (3 s.h.)

EWRE 345 Water Resources Engineering - Case studies of important problems in water resources engineering. Stratified flow, thermal pollution, eutrophication, tracer techniques, optimization techniques, submerged jets, hydraulic models, water power engineering, and water resources planning. (3 s.h.)

EWRE 362 Management of Solid Waste Collection Systems - Selected problems pertaining to reference materials, methods of collection, methods of storage, equipment and transportation. Comparison of municipal, contract, and private collection systems. Financing refuse collection operations, organization, personnel, equipment management, cost accounting and budgeting, and public relations. Analysis and planning of refuse collection systems. (3 s.h.)

EWRE 363 The Management of Solid Waste Disposal Systems - Quantities and composition of refuse, selecting disposal methods, sanitary landfill, analysis of central incineration, composting, salvage, reuse, reclamation, reprocessing, and recycling. Design and analysis of refuse disposal systems. (3 s.h.)

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INSTITUTION: VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

PROGRAM: Sanitary Engineering/Environmental Sciences and Engineering/Civil Engineering
DEPARTMENT: Civil Engineering
DEGREE: Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Paul H. King
Chairman, Environmental Sciences and Engineering
Civil Engineering Department
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061
(703) 951-6131

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental sciences and engineering/Civil engineering/ Sanitary engineering at VPI consists of five degree programs, all interrelated and designed to prepare students with a good background in several areas of environmental control. Sanitary engineering was initiated at VPI in 1945 and the environmental engineering programs established in 1968.

The environmental sciences and engineering program offers the broadest range of training, preparing students in air pollution control, water supply, and waste water. This program is designed primarily for students with undergraduate degrees in the physical or life sciences, rather than engineering. Both a Master's Degree and a Ph.D are offered in this program.

Sanitary engineering and civil engineering are water quality oriented programs and are designed for students with undergraduate degrees in engineering. Master's Degrees are offered in both Sanitary Engineering and in Civil Engineering with majors in hydraulic engineering, sanitary engineering, and water resources engineering. A Ph.D. is offered in Civil Engineering with majors in hydraulic or water resources engineering and Sanitary Engineering.

The programs are supported not only by the university but through outside funding sources such as EPA research and training grants, state environmental funds, and the federal Office of Water Research and Technology (Dept. of the Interior). In addition, the programs have their own laboratory facilities including a joint facility with the plant pathology department on effects of air pollution and a water monitoring field laboratory in Northern Virginia.

PROGRAM REQUIREMENTS

Requirements for all the M.S. programs generally include an undergraduate degree from an accredited program with an average of 2.7/4 or higher. It is preferred that students in the engineering programs have undergraduate degrees in civil, mechanical, chemical, or agricultural engineering, while environmental sciences students may have degrees in an engineering discipline or in a physical or life science.

Admission to the Ph.D. program generally requires a Master's Degree in engineering or in the case of environmental sciences, an M.S. in a physical or life science.

Degree requirements in the M.S. programs require a minimum of forty-five quarter hours, with nine to fifteen hours applied to a thesis. The engineering programs require nine credit hours in design, six in chemistry, four in microbiology, and three in analysis laboratory. The requirements in environmental science are the same except for the substitution of nine hours in the student's primary discipline in lieu of design.

The Ph.D. requirements include one hundred and thirty five quarter hours, of which between fifty and seventy may be applied to research and dissertation. Students must also demonstrate proficiency in reading one foreign language or complete an additional six credit hours in non-technical electives.

CURRENT FACULTY, STUDENTS, GRADUATES

There are seven faculty members participating in these programs, five of whom primarily teach, and two of whom are principally concerned with research. In addition, six other faculty members teach some courses in the program. The environmental sciences program draws upon faculty from other departments such as aerospace and ocean engineering, agricultural engineering, mining engineering, biology, chemistry, forestry and wildlife, and statistics.

Currently, there are fifteen full-time and three part-time students in the sanitary engineering M.S. program, fifteen full-time and two part-time in the environmental sciences M.S. program, and five in the Civil Engineering M.S. program in environmental options. There are also four students in each of the two Ph.D. programs.

Approximately sixty percent of the students come from Virginia and come to VPI through various recruiting methods such as alumni contacts, program flyers and listing in Peterson's Guide. About sixty percent of the students receive some form of financial aid which currently includes six EPA training grants, six teaching assistantships, six research assistantships, three fellowships, and four grants from the state which pay one-half salary plus tuition for employees.

Most graduates directly enter the workforce rather than continuing on to further degrees. It is estimated that about ninety percent find employment in their field, with about fifty percent going to the private sector, forty percent into government jobs, and the remainder into other positions such as teaching and research. Graduates are generally placed in positions through faculty contacts with employers.

PROGRAM PROJECTIONS

It is anticipated that current program levels will be maintained and that there is no need for expansion at this time. There is the possibility of adding one faculty member, specializing in water programs, in the next two years.

ADDITIONAL INFORMATION

Program faculty members conduct short courses each year for the Virginia State Water Control Board. This includes an operator training program each summer in which about four hundred operators receive training in preparation for state certification.

COURSE DESCRIPTION (SELECTED)

CE 4260 Introduction to Air Pollution - Scientific, engineering and legal aspects of air pollution with remedies and controls. (3 q.h.)

CE 4041, 4042, 4043 Sanitary Engineering - Processes for water purification and sewage treatment. (3 q.h.)

CE 5100 Advanced Sanitary Engineering - Principles of organic chemistry and biochemistry as applied to sanitary engineering systems. (3 q.h.)

CE 5230 Water Quality Waste Treatment - Advanced methods for research in biological and chemical treatment processes. (3 q.h.)

CE 5121 Sanitary Engineering Design - Design of treatment components and systems. (3 q.h.)

CE 5131 Public Health Engineering - Environmental sanitation, epidemiology, milk and food sanitation, solid waste disposal, industrial hygiene. (3 q.h.)

CE 5093 Air Pollution - Facilities and techniques for design of control programs for air pollution. (3 q.h.)

CE 5400 Solid Waste Practices - Current solid waste management practices. (3 q.h.)

CE 5082 Water Resources Engineering - Water resources planning, economics of water resource developments. (3 q.h.)

CE 5083 Water Resources Engineering - Design of water resources systems. (3 q.h.)

CE 6062 Advanced Engineering Hydraulics - Potential flow theory; boundary layers; turbulence; application in hydraulic design. (3 q.h.)

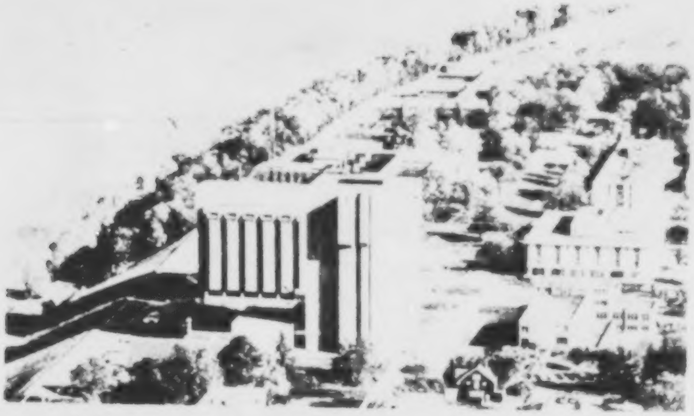
Stat 5090 Stochastic Modeling of Pollution: Water - Development and evaluation of stochastic models used in water pollution; dynamic regression, and stochastic models will be developed for several biodegradable processes. (3 q.h.)

Biol 5050 Environmental Science Water - Interdisciplinary seminar course in pollution assessment, waste treatment, aquatic communities, bioassays of toxicants, application factors for disposal of toxicants, problems of pollution control legislation. (2 q.h.)

Biol 5060 Water Resource Management - Seminar course, primarily for ecology and sanitary engineering, to discuss current problems and research in both fields. (2 q.h.)

Geol 4110 Ground Water Hydrology - Sources, occurrence, inventory, utilization, and recharge of ground water in the earth's crust. (3 q.h.)

Geol 4400 Environmental Geology - Applications of geologic knowledge to problems and activities associated with urban and regional development: water resources, mineral resources, waste disposal, subsurface storage, construction and physical planning. (3 q.h.)



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APPENDICES

Photo reprinted from the University of Illinois Institute of Technology Booklet

Photo reprinted from the Indiana University of Public and Environmental Affairs Catalog 1977-78

APPENDIX I

DEGREE ABBREVIATIONS

APPENDIX I

Degree Abbreviations

A.A.	Associate of Arts
A.A.Ag.	Associate of (in) Applied Agriculture
A.Ag.	Associate of (in) Agriculture
A.A.P.C.T.	Associate Degree in Air Pollution Control Technology
A.A.S.	Associate of Applied Science
A.B.	Bachelor of Arts
A.D.	Associate Degree
A.E.T.	Associate in Engineering Technology
A.M.T.	Associate of Mining Technology
A.N.E.T.	Associate of Nuclear Engineering Technology
A.S.	Associate in Science
A.S.E.M.T.	Associate of Science in Engineering Mining Technology
A.T.	Associate of Technology
B.A.	Bachelor of Arts
B.E.M.T.	Bachelor of Engineering in Mining Technology
B.S.	Bachelor of Science
B.S. (N.E.)	Bachelor of Science in Nuclear Engineering
B.S. (N.E.S.)	Bachelor of Science (Nuclear Engineering Sciences)
B.S. (N.R.)	Bachelor of Science in Natural Resources
B.S.A.	Bachelor of Science in Agriculture
B.S.C.E.	Bachelor of Science in Civil Engineering
B.S.Ch.E.	Bachelor of Science in Chemical Engineering
B.S.E.	Bachelor of Science in Engineering
B.S.E.H.	Bachelor of Science in Environmental Health
B.S.E. (N.E.)	Bachelor of Science (Nuclear Engineering)
B.S.E.S.	Bachelor of Science in Engineering Sciences
B.S.N.E.	Bachelor of Science in Nuclear Engineering
B.T.	Bachelor of Technology
Cert.	Certificate

D.E.	Doctor of Engineering
D.P.H.	Doctor of Public Health
D.S.	Doctor of Science
D.S. (Hyg.)	Doctor of Science Hygiene
D.Sc.	Doctor of Science
Dr.P.H.	Doctor of Public Health

E.E.	Environmental Engineer
Eng.	Engineer
Engr.	Engineer
Engr.Sc.D.	Doctor of Engineering Science
Env.E.	Environmental Engineer
Envir.Eng.	Environmental Engineer

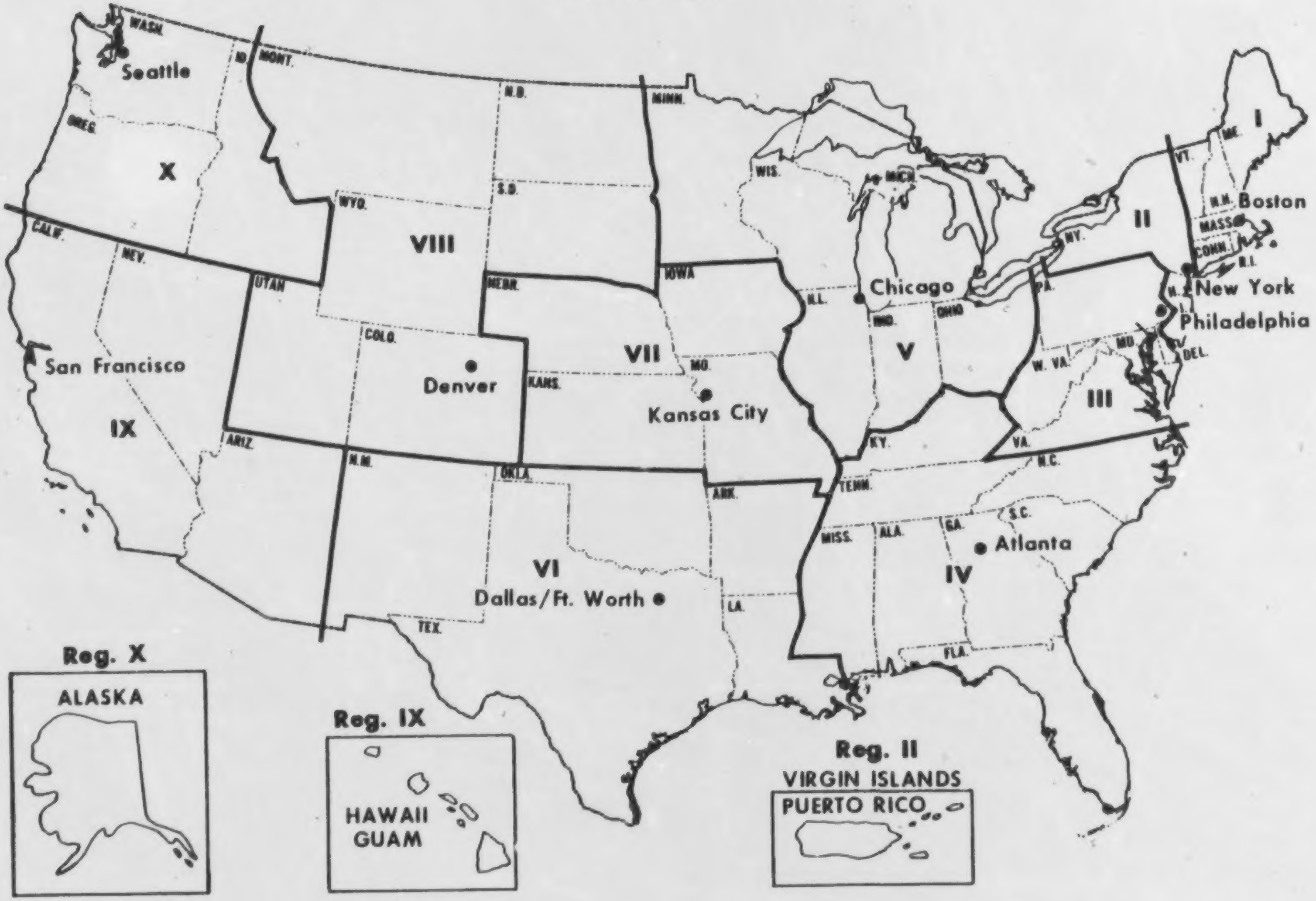
M.A.	Master of Arts
M.Ag.	Master of Agriculture
M.Agr.	Master of Agriculture
M.A.S.	Master of Applied Science
M.C.E.	Master of Civil Engineering
M.E.	Master of Engineering
M.E.E.E.	Master of Engineering in Environmental Engineering
M.E.A.S.	Master of Environmental Arts and Science
M.E.H.S.	Master of Environmental Health Sciences
M.E.M.	Master of Environmental Management
M.E.P.C.	Master in Environmental Pollution Control
M.Eng.	Master of Engineering
M.Engr.	Master of Engineering
M.F.	Master of Forestry
M.M.E.	Master of Mechanical Engineering
M.P.	Master of Philosophy
M.P.A.	Master of Public Affairs
M.P.H.	Master of Public Health
M.P.P.P.M.	Master of Plant Protection and Pest Management

M.P.S.	Master of Professional Studies
M.S.	Master of Science
M.S. (Hyg.)	Master of Science Hygiene
M.S.C.E.	Master of Science in Civil Engineering
M.S.Ch.E.	Master of Science in Chemical Engineering
M.S.E.	Master of Science in Engineering
M.S.E.E.	Master of Science in Environmental Engineering
M.S.En.E.	Master of Science in Environmental Engineering
M.S.Eng. S.	Master of Science in Environmental Engineering
M.S.Eng. Sci.	Master of Science in Engineering Science
M.S.E.H.	Master of Science in Environmental Health
M.S.E.M.P.	Master of Science in Energy Management and Policy
M.S.E.S.	Master of Science in Environmental Science (Studies)
M.S.P.H.	Master of Science in Public Health
M.S.(S.E.)	Master of Science in Sanitary Engineering
M.S.(S.S.)	Master of Science in Sanitary Science
N.E.	Nuclear Engineering
Nuc. Eng.	Nuclear Engineering
Ph.D.	Doctor of Philosophy
S.B.	Bachelor of Science
Sc.D.	Doctor of Science
S.M.	Master of Science

APPENDIX II

TERMINOLOGY

STANDARD REGIONAL BOUNDARIES
TEN REGIONS


WASH.
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OREG.
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S.D.
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VIII
WIS.
MICH.
ME.
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VT.
N.H.
Boston
MASS.
CONN.
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II
N.Y.
CALIF.
NEV.
UTAH
NEBR.
IOWA
ILL.
Chicago
IND.
OHIO
PA.
N.J.
New York
Philadelphia
COLO.
Denver
San Francisco
VII
KANS.
MO.
Kansas City
V
W. VA.
MD.
DEL.
III
IX
ARIZ.
N.M.
OKLA.
KY.
VA.
N.C.
TENN.
ARK.
S.C.
MISS.
ALA.
GA.
Atlanta
VI
Dallas/Ft. Worth
IV
LA.
TEX.
FLA.
Reg. X
ALASKA
Reg. IX
HAWAII
GUAM
Reg. II
VIRGIN ISLANDS
PUERTO RICO

TERMINOLOGY

ACT (American College Testing) and SAT (Scholastic Aptitude Test) - Standardized examinations which are intended to provide applicants and institutions with a numerical statement of an individual's ability and readiness to successfully complete college/university level work.

Co-op program - A plan whereby a student receives financial assistance and academic credit under the direction of a cooperating employment site representative and a faculty advisor in exchange for an agreed upon condition of employment. Students must complete all degree requirements as per the norm.

Course - For the purpose of this study, a course is considered a unit of a program, in which a body of knowledge is presented, the satisfactory completion of which leads to the awarding of a predetermined or individually arranged number of credits.

ECPD (Engineers' Council for Professional Development) - Accrediting body for programs in engineering technology.

ERIC (Educational Resources Information Center) - A national information system designed and developed by the U.S. Office of Education, and now supported and operated by the National Institute of Education (NIE), for providing ready access to descriptions of exemplary programs, research and development efforts, and related information that can be used in developing more effective educational programs.

GRE (Graduate Record Examination) - (General Aptitude) An examination of verbal and mathematical competency and aptitude, which is designed to provide a numerical indication of an individual's ability to successfully complete advanced level work. For the purposes of the study, the GRE will not refer to the Advanced Examinations.

Internship/Applied Study Term - An arrangement which is intended to provide a simulation of work experience under the direction of academic advisors and is designed to be an integral segment of an individual's academic program. (College credit may be given.)

IRIS (Instructional Resources Information System) - A computerized information base listing materials relating to education and training in the water quality control field, which is located in the National Training and Operational Technology Center of the U.S. Environmental Protection Agency.

MEDLINE - Computerized literature search services with application to medical information.

NTIS (National Technical Information Service) - Computerized literature search services.

Program - For the purpose of this study, a plan of study, either completely prescribed, or containing options, with an identity of its own, and standard rules and procedures, the satisfaction of which may lead to a degree, certificate, or diploma.

Quarter hours - vs. - Semester hours - One semester hour is the credit equivalent to one and a half quarter hours.

Standard Federal Boundaries - Geographic division of the United States for the purposes of decentralized administration; in this report also referred to as EPA regions (see map on preceding page).

TOXLINE - Computerized literature search services with particular application to the recall of information concerning toxic substances.

WRSIC (Water Resources Scientific Information Center) - Collects, screens, organizes and disseminates reports in water resources.

APPENDIX III

SELECTED BIBLIOGRAPHY

SELECTED BIBLIOGRAPHY

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APPENDIX IV

PARTICIPATING INSTITUTIONS
BY
ENVIRONMENTAL CATEGORY

APPENDIX IV

PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
AIR	Carnegie-Mellon University	Pittsburgh, PA
	Clemson University	Clemson, SC
	Drexel University	Philadelphia, PA
	George Washington University-NASA	Hampton, VA
	Harvard University School of Public Health	Boston, MA
	Hudson Valley Community College	Troy, NY
	Massachusetts Institute of Technology	Ithaca, NY
	Michigan Technological University	Houghton, MI
	Middlesex County College	Edison, NJ
	Muskingum Area Technical College	Zanesville, OH
	New Jersey Institute of Technology	Newark, NJ
	North Carolina State University	Chapel Hill, NC
	North Dakota State School of Science	Wahpeton, ND
	Northeastern University	Boston, MA
	Ohio State University	Columbus, OH
	Portland State University	Portland, OR
	Prairie State Community College	Chicago Heights, IL
	Purdue University	West Layfayette, IN
	Rensselaer Polytechnic Institute	Troy, NY
	Rutgers-The State University of New Jersey	New Brunswick, NJ
	Springfield Technical Community College	Springfield, MA
	Stevens Institute of Technology	Hoboken, NJ
	Sumter University	Sumter, SC
	Syracuse University	Syracuse, NY
	Temple University	Philadelphia, PA
	The Pennsylvania State University	University Park, PA
	University of Cincinnati	Cincinnati, OH
	University of Delaware	Newark, DE
	University of Florida	Gainesville, FL
	University of Iowa	Iowa City, IA
	University of Kentucky	Lexington, KY
	University of Maryland	College Park, MD
	University of Michigan	Ann Arbor, MI
	University of Missouri-Rolla	Rolla, MO
	University of North Carolina	Chapel Hill, NC
	University of Pittsburgh	Pittsburgh, PA
	University of Tennessee	Knoxville, TN
	University of Texas-Austin	Austin, TX
	University of Washington	Seattle, WA
	University of Wisconsin-Milwaukee	Milwaukee, WI
	Vanderbilt University	Nashville, TN
	Washington State University	Pullman, WA
	Washington University	St. Louis, MO
	West Virginia University	Morgantown, WV
	Yale University	New Haven, CT

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
COMPOSITE:	Antioch College	Yellow Springs, OH
	Baylor University	Waco, TX
	Bemidji State University	Bemidji, MN
	California Institute of Technology	Pasadena, CA
	California Polytechnic State University	San Luis Obispo, CA
	Catholic University of America	Washington, DC
	Carnegie-Mellon University	Pittsburgh, PA
	Chattanooga State Technical Community College	Chattanooga, TN
	Clarkson College	Potsdam, NY
	Clemson University	Clemson, SC
	Cornell University	Ithaca, NY
	Delaware Technical and Community College	Newark, DE
	Delgado College	New Orleans, LA
	Drexel University	Philadelphia, PA
	Duke University	Durham, NC
	East Central Oklahoma State University	Ada, OK
	East Tennessee State University	Johnson City, TN
	Evergreen State College	Olympia, WA
	Ferris State College	Big Rapids, MI
	Florida International University	Miami, FL
	Georgia Institute of Technology	Atlanta, GA
	Heed University	Hollywood, FL
	Hocking Technical College	Nelsonville, OH
	Howard University	Washington, DC
	Hunter College	New York, NY
	Indiana University	Bloomington, IN
	Iowa State University	Ames, IA
	Johns Hopkins University	Baltimore, MD
	Kansas State University	Manhattan, KS
	Kirkwood Community College	Cedar Rapids, IA
	Lamar University	Beaumont, TX
	Macalester College	St. Paul, MN
	Massachusetts Institute of Technology	Cambridge, MA
	McNeese State University	Lake Charles, LA
	Miami University	Oxford, OH
	Michigan State University	East Lansing, MI
	Middle Tennessee State University	Murfreesboro, TN
	Morehead State University	Morehead, KY
	Muskingum Area Technical College	Zanesville, OH
	New Jersey Institute of Technology	Newark, NJ
	North Carolina State University	Raleigh, NC
	Northland College	Ashland, WI
	Ohio State University	Columbus, OH

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
COMPOSITE: (Cont'd)	Ohio University	Athens, OH
	Oscar Rose Junior College	Midwest City, OK
	OSU Oklahoma City Technical Institute	Oklahoma City, OK
	Polytechnical Institute of New York	Brooklyn, NY
	Princeton University	Princeton, NJ
	Purdue University	West Lafayette, IN
	Raymond Walters General and Technical College (University of Cincinnati	Cincinnati, OH
	Rensselaer Polytechnical Institute	Troy, NY
	Rutgers University	New Brunswick, NJ
	Sam Houston State University	Huntsville, TX
	Sangamon State University	Springfield, IL
	Slippery Rock State College	Slippery Rock, PA
	Springfield Technical and Community College	Springfield, MA
	Stevens Institute of Technology	Hoboken, NJ
	Syracuse University	Syracuse, NY
	Temple University	Philadelphia, PA
	Texas A & M University	College Station, TX
	The Cooper Union	New York, NY
	The Pennsylvania State University	University Park, PA
	University of Alabama	University, AL
	University of Alaska	Fairbanks, AK
	University of Arkansas	Fayetteville, AR
	University of California-Santa Barbara	Santa Barbara, CA
	University of Cincinnati	Cincinnati, OH
	University of Delaware	Newark, DE
	University of Florida	Gainesville, FL
	University of Georgia	Athens, GA
	University of Kansas	Lawrence, KS
	University of Louisville	Louisville, KY
	University of Maine-Orono	Orono, Maine
	University of Michigan	Ann Arbor, MI
	University of Minnesota	Minneapolis, MN
	University of North Carolina	Chapel Hill, NC
	University of Oklahoma	Norman, OK
	University of Pittsburgh	Pittsburgh, PA
	University of Tennessee	Knoxville, TN
	University of Toledo	Toledo, OH
	University of Utah	Salt Lake City, UT
	University of Washington	Seattle, WA
	University of Wisconsin-Green Bay	Green Bay, WI
	University of Wisconsin-Madison	Madison, WI
	Utah State University	Logan, UT

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
COMPOSITE: (Cont'd)	Vanderbilt University	Nashville, TN
	Virginia Polytechnic Institute and State University	Blacksburg, VA
	Washington State University	Pullman, WA
	Western Kentucky University	Bowling Green, KY
	Western Washington University (Huxley College of Environmental Studies)	Bellingham, WA
	West Virginia University	Morgantown, WV
	Yale University	New Haven, CT
ENERGY:	Bluefield State College	Bluefield, WV
	Brigham Young University	Provo, UT
	Carnegie-Mellon University	Pittsburgh, PA
	Columbia University	New York, NY
	Cornell University	New York, NY
	Georgia Institute of Technology	Atlanta, GA
	Hartford State Technical College	Hartford, CT
	Kansas State University	Manhattan, KS
	Lamar University	Beaumont, TX
	Massachusetts Institute of Technology	Cambridge, MA
	Morehead State University	Morehead, KY
	Muskingum Area Technical College	Zanesville, OH
	Oregon State University	Corvallis, OR
	Pikeville College	Pikeville, KY
	Polytechnic Institute of New York	Brooklyn, NY
	Princeton University	Princeton, NJ
	Purdue University	West Lafayette, IN
	Rensselaer Polytechnic Institute	Troy, NY
	Southern Technical Institute	Marietta, GA
	Texas State Technical Institute	Waco, TX
	The Pennsylvania State University	University Park, PA
	University of California-Berkeley	Berkeley, CA
	University of Florida	Gainesville, FL
	University of Kentucky	Lexington, KY
	University of New Mexico	Albuquerque, NM
	University of Pennsylvania	Philadelphia, PA
	University of Tennessee	Knoxville, TN
	West Virginia Institute of Technology	Montgomery, WV
	West Virginia University	Morgantown, WV

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
NOISE:	George Washington University-NASA	Hampton, VA
	Georgia Institute of Technology	Altanta, GA
	Massachusetts Institute of Technology	Cambridge, MA
	Memphis State University	Memphis, TN
	North Carolina State University	Raleigh, NC
	The Pennsylvania State University	University Park, PA
	University of Cincinnati	Cincinnati, OH
	University of Pittsburgh	Pittsburgh, PA
	University of Tennessee	Knoxville, TN
	University of Tennessee Center for Health Sciences	Memphis, TN
PESTICIDES:	Abraham Baldwin Agricultural College	Tifton, GA
	Broward Community College	Ft. Lauderdale, FL
	Central Technical Community College	Hastings, NE
	Delgado Community College	New Orleans, LA
	Harvard University School of Public Health	Boston, MA
	Mississippi State University	Mississippi State, MS
	New Mexico State University	Las Cruces, NM
	North Carolina State University	Raleigh, NC
	Ohio State University	Columbus, OH
	Oregon State University	Corvallis, OR
	Rutgers State University of New Jersey	New Brunswick, NJ
	State University of New York at Farmingdale	Farmingdale, NY
	Texas A & M University	College Station, TX
	The Pennsylvania State University	University Park, PA
	University of California-Berkeley	Berkeley, CA
	University of California-Davis	Davis, CA
	University of California-Riverside	Riverside, CA
	University of Cincinnati	Cincinnati, OH
	University of Delaware	Newark, DE
	University of Georgia	Athens, GA
	University of Iowa	Iowa City, IA
	University of Maryland	College Park, MD
	University of New Hampshire	Durham, NH
	University of Pittsburgh	Pittsburgh, PA
	University of Rochester	Rochester, NY
	Utah State University	Logan, UT

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
POTABLE WATER:	Atlanta University Center/Georgia Institute of Technology	Atlanta, GA
	Brigham Young University	Provo, UT
	California State University	Sacramento, CA
	Carnegie-Mellon University	Pittsburgh, PA
	Casper College	Casper, WY
	Central Technical Community College	Hastings, NE
	Clarkson College	Potsdam, NY
	Clemson University	Clemson, SC
	Colorado State University	Fort Collins, CO
	Community College of Denver-Red Rocks	Golden, CO
	Cornell University	Ithaca, NY
	Delgado College	New Orleans, LA
	Drexel University	Philadelphia, PA
	East Maine Vocational Technical Institute	Bangor, ME
	Hudson Valley Community College	Troy, NY
	Illinois Institute of Technology	Chicago, IL
	Iowa State University	Ames, IA
	J. Sargeant Reynolds Community College	Richmond, VA
	Kansas State University	Manhattan, KS
	Kirkwood Community College	Cedar Rapids, IA
	Linn-Benton Community College	Albany, OR
	Manhattan College	New York, NY
	Marquette University	Milwaukee, WI
	Massachusetts Institute of Technology	Cambridge, MA
	Miami-Dade Community College	Miami, FL
	Michigan Technological University	Houghton, MI
	Middlesex Community College	Edison, NJ
	Missouri Southern State College	Joplin, MO
	Montana State University	Bozeman, MT
	Muskingum Area Technical College	Zanesville, OH
	Northeastern University	Boston, MA
	Northern Montana College	Havre, MT
	Ohio State University	Columbus, OH
	Operator Training Center	Murfreesboro, TN
	Oregon Institute of Technology	Klamath Falls, OR
	Oscar Rose Junior College	Midwest City, OK
	Purdue University	West Lafayette, IN
	Rensselaer Polytechnic Institute	Troy, NY
	Rice University	Houston, TX
	Rochester Institute of Technology	Rochester, NY
	Rutgers State University of New Jersey	New Brunswick, NJ
	Southern Illinois University	Edwardsville, IL

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
POTABLE WATER: (Cont'd)	Springfield Technical Community College	Springfield, MA
	Stanford University	Stanford, CA
	State University of New York at Buffalo	Buffalo, NY
	Stevens Institute of Technology	Hoboken, NJ
	Sumter Technical Community College	Sumter, SC
	Syracuse University	Syracuse, NY
	Temple University	Philadelphia, PA
	Texas State Technical Institute	Waco, TX
	The Pennsylvania State University	University Park, PA
	The Pennsylvania State University/ Capitol Campus	Middletown, PA
	Tufts University	Boston, MA
	Ulster County Community College	Stone Ridge, NY
	University of California-Berkeley	Berkeley, CA
	University of Florida	Gainesville, FL
	University of Hawaii	Honolulu, HI
	University of Iowa	Iowa City, IA
	University of Kansas	Lawrence, KS
	University of Kentucky	Lexington, KY
	University of Maine at Orono	Orono, ME
	University of Michigan	Ann Arbor, MI
	University of Missouri-Columbia	Columbia, MO
	University of Missouri-Rolla	Rolla, MO
	University of Nebraska	Lincoln, NE
	University of North Carolina	Chapel Hill, NC
	University of Pennsylvania	Philadelphia, PA
	University of Pittsburgh	Pittsburgh, PA
	University of Rhode Island	Kingston, RI
	University of Tennessee	Knoxville, TN
	University of Texas-Austin	Austin, TX
	University of Wisconsin-Madison	Madison, WI
	University of Wyoming	Laramie, WY
	Utah State University	Logan, UT
	Vanderbilt University	Nashville, TN
	Virginia Polytechnic Institute and State University	Blacksburg, VA
	Water and Wastewater Technical School	Neosho, MO
	West Georgia College	Carrollton, GA
	West Virginia University	Morgantown, WV
	Wytheville Community College	Wytheville, VA

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
RADIATION:	Central Florida Community College	Ocala, FL
	Chattanooga State Technical Community College	Chattanooga, TN
	Columbia University	New York, NY
	Cornell University	Ithaca, NY
	Hartford State Technical College	Hartford, CT
	Harvard University School of Public Health	Boston, MA
	Kansas State University	Manhattan, KS
	Massachusetts Institute of Technology	Cambridge, MA
	Memphis State University	Memphis, TN
	Missouri Southern State College	Joplin, MO
	Oak Ridge Associated Universities	Oak Ridge, TN
	Oklahoma State University	Stillwater, OK
	Rensselaer Polytechnic Institute	Troy, NY
	Rutgers State University of New Jersey	New Brunswick, NJ
	St. Louis Community College at Forest Park	St. Louis, MO
	Southern Technical Institute	Marietta, GA
	The Pennsylvania State University	University Park, PA
	University of Florida	Gainesville, FL
	University of Kansas	Lawrence, KS
	University of Lowell	Lowell, MA
	University of Maryland	College Park, MD
	University of Michigan	Ann Arbor, MI
	University of North Carolina	Chapel Hill, NC
	University of Pittsburgh	Pittsburgh, PA
	University of Tennessee	Knoxville, TN
SOLID WASTE:	Carnegie-Mellon University	Pittsburgh, PA
	Clarkson College	Potsdam, NY
	Cornell University	New York, NY
	Drexel University	Philadelphia, PA
	Hofstra University	Hempstead, NY
	Michigan Technological University	Houghton, MI
	Rensselaer Polytechnic Institute	Troy, NY
	Temple University	Philadelphia, PA
	The Pennsylvania State University	University Park, PA
	University of Iowa	Iowa City, IA
	University of Missouri-Rolla	Rolla, MO
	University of Pittsburgh	Pittsburgh, PA
	Vanderbilt University	Nashville, TN
	West Virginia University	Morgantown, WV
	Wilson County Technical Institute	Wilson, NC
	Yale University	New Haven, CT

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
WASTEWATER:	Atlanta University Center/ Georgia Institute of Technology	Atlanta, GA
	Brigham Young University	Provo, UT
	California State University-Sacramento	Sacramento, CA
	Carnegie-Mellon University	Pittsburgh, PA
	Casper College	Casper, WY
	Central Technical Community College	Hastings, NE
	Charles County Community College	La Plata, MD
	Clarkson College	Potsdam, NY
	Clemson University	Clemson, SC
	Colorado State University	Fort Collins, CO
	Community College of Denver-Red Rocks	Golden, CO
	Cornell University	Ithaca, NY
	Delgado College	New Orleans, LA
	Drexel University	Philadelphia, PA
	East Maine Vocational Technical Institute	Bangor, ME
	Greenville Technical College	Greenville, SC
	Harvard University	Cambridge, MA
	Hudson Valley Community College	Troy, NY
	Illinois Institute of Technology	Chicago, IL
	Iowa State University	Ames, IA
	J. Sargeant Reynolds Community College	Richmond, VA
	Kansas State University	Manhattan, KS
	Kirkwood Community College	Cedar Rapids, IA
	Linn-Benton Community College	Albany, OR
	Manhattan College	New York, NY
	Marquette Technical University	Milwaukee, WI
	Massachusetts Institute of Technology	Cambridge, MA
	Miami-Dade Community College	Miami, FL
	Michigan Technological University	Houghton, MI
	Middlesex County College	Edison, NJ
	Missouri Southern State College	Joplin, MO
	Montana State University	Bozeman, MT
	Muskingum Area Technical College	Zanesville, OH
	New England Regional Wastewater Institute	S. Portland, ME
	New Jersey Institute of Technology	Newark, NJ
	Northeastern University	Boston, MA
	Northern Montana College	Havre, MT
	Ohio State University	Columbus, OH
	Operator Training Center	Murfreesboro, TN
	Oregon Institute of Technology	Klamath Falls, OR
	Oscar Rose Junior College	Midwest City, OK

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
WASTEWATER: (Cont'd)	Purdue University	West Lafayette, IN
	Rensselaer Polytechnic Institute	Troy, NY
	Rice University	Houston, TX
	Rochester University	Rochester, NY
	Rutgers State University of New Jersey	New Brunswick, NJ
	Southern Illinois University	Edwardsville, IL
	Springfield Technical and Community College	Springfield, MA
	Stanford University	Stanford, CA
	State Technical Institute at Memphis	Memphis, TN
	State University of New York-Buffalo	Buffalo, NY
	Stevens Institute of Technology	Hoboken, NJ
	Sumter Technical Community College	Sumter, SC
	Syracuse University	Syracuse, NY
	Temple University	Philadelphia, PA
	Texas State Technical Institute	Waco, TX
	The Pennsylvania State University	University Park, PA
	The Pennsylvania State University/Capitol Campus	Middletown, PA
	Tufts University	Boston, MA
	Ulster County Community College	Stone Ridge, NY
	University of California-Berkeley	Berkeley, CA
	University of Florida	Gainesville, FL
	University of Hawaii	Honolulu HI
	University of Kansas	Lawrence, KS
	University of Kentucky	Lexington, KY
	University of Lowell	Lowell, MA
	University of Maine at Orono	Orono, ME
	University of Missouri-Columbia	Columbia, MO
	University of Missouri-Rolla	Rolla, MO
	University of Nebraska	Lincoln, NE
	University of North Carolina	Chapel Hill, NC
	University of Pittsburgh	Pittsburgh, PA
	University of Rhode Island	Kingston, RI
	University of Tennessee	Knoxville, TN
	University of Texas	Austin, TX
	University of Wisconsin-Madison	Madison, WI
	University of Wyoming	Laramie, WY
	Utah State University	Logan, UT
	Vanderbilt University	Nashville, TN
	Virginia Polytechnic Institute and State University	Blacksburg, VA
	Water and Wastewater Technical School	Neosho, MO
	West Georgia College	Carrollton, GA
	West Virginia University	Morgantown, WV
	Wytheville Community College	Wytheville, VA

APPENDIX V

COLLEGE CATALOGS REVIEWED

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
AL	Alabama A & M University	Huntsville
	Alabama Christian College	Montgomery
	Alabama Lutheran Junior College	Selma
	Alexander City State Junior College	Alexander City
	Athens State College	Athens
	Auburn University	Auburn
	Auburn University at Montgomery	Montgomery
	Birmingham-Southern College	Birmingham
	Brewer State Junior College	Fayette
	Enterprise State Junior College	Enterprise
	Faulkner State Junior College	Bay Minette
	Gadsden State Junior College	Gadsden
	George C. Wallace State Community College	Dothan
	George C. Wallace State Community College	Selma
	Jacksonville State University	Jacksonville
	Jefferson Davis State Junior College	Brewton
	Jefferson State Junior College	Birmingham
	John C. Calhoun State Community College	Decatur
	Judson College	Marion
	Livingston University	Livingston
	Lawson State Community College	Birmingham
	Lurleen B. Wallace State Junior College	Andalusia
	Marion Military Institute	Marion
	Miles College	Birmingham
	Mobile College	Mobile
	Northeast Alabama State Junior College	Rainsville
	Northwest Alabama State Junior College	Phil Campbell
	Oakwood College	Huntsville
	Samford University	Birmingham
	Selma University	Selma
	Snead State Junior College	Boaz
	Southeastern Bible College	Birmingham
	Southern Benedictine College	Saint Bernard
	Southern Union State Junior College	Wadley
	Spring Hill College	Mobile
	Stillman College	Tuscaloosa
	Talladega College	Talladega
	Troy State University	Troy
	Tuskeegee Institute	Tuskeegee Institute
	University of Alabama	University
	University of Alabama in Birmingham	Birmingham
	University of Alabama in Huntsville	Huntsville
	University of Montevallo	Montevallo
	University of North Alabama	Florence
	University of South Alabama	Mobile
	Walker College	Jasper
AK	Sheldon Jackson College	Sitka
	University of Alaska-Fairbanks	Fairbanks
	University of Alaska Juneau Senior College	Juneau
AS	American Samoa Community College	Pago Pago
AZ	American Graduate School of International Management	Glendale
	Arizona State University	Tempe
	Arizona Western College	Yuma

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Central Arizona College	Coolidge
	Cochise College	Douglas
	College of Ganado	Ganado
	DeVry Institute of Technology	Phoenix
	Eastern Arizona College	Thatcher
	Grand Canyon College	Phoenix
	Maricopa County Community College System Office	Phoenix
	Glendale Community College	Glendale
	Maricopa Technical Community College	Phoenix
	Mesa Community College	Mesa
	Phoenix College	Phoenix
	Scottsdale Community College	Scottsdale
	Mohave Community College	Kingman
	Navajo Community College	Tsaile
	Northern Arizona University	Flagstaff
	Northland Pioneer College	Holbrook
	Pima Community College	Tucson
	Southwestern College	Phoenix
	University of Arizona	Tucson
	Yavapai College	Prescott
AR	Arkansas College	Batesville
	Arkansas State University-Main Campus	State University
	Arkansas State University-Beebe Branch	Beebe
	Arkansas Tech University	Russellville
	Central Baptist College	Conway
	College of the Ozarks	Clarksville
	Crowley's Ridge College	Paragould
	Garland County Community College	Hot Springs
	Harding College-Main Campus	Searcy
	Henderson State University	Arkadelphia
	Hendrix College	Conway
	John Brown University	Siloam Springs
	Mississippi County Community College	Blytheville
	Quachita Baptist University	Arkadelphia
	Philander Smith College	Little Rock
	Phillips County Community College	Helena
	Southern Arkansas University	Magnolia
	Southern Arkansas University Southwest Technical Institute	East Camden
	Southern Baptist College	Walnut Ridge
	Southern State College	Magnolia
	University of Arkansas-Main Campus	Fayetteville
	University of Arkansas-Little Rock	Little Rock
	University of Arkansas Medical Sciences Campus	Little Rock
	University of Arkansas-Monticello	Monticello
	Westlark Community College	Fort Smith
CA	Allan Hancock College	Santa Maria
	Ambassador College	Pasadena
	American Baptist Seminary of the West-Central Office	Berkeley
	American Baptist Seminary of the West-Covina	Covina
	Armstrong College	Berkeley
	Azusa Pacific College	Azusa
	Bakersfield College	Bakersfield
	Barstow College	Barstow
	Bauder College	Sacramento
	Bethany Bible College	Santa Cruz
	Biola College	La Mirada
	Brooks College	Long Beach

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Brooks Institute of Santa Barbara	Santa Barbara
	Butte College	Oroville
	Cabrillo College	Aptos
	California Baptist College	Riverside
	California College of Arts and Crafts	Oakland
	California Institute of the Arts	Valencia
	California Institute of Asian Studies	San Francisco
	California Institute of Technology	Pasadena
	California Lutheran College	Thousand Oaks
	California Maritime Academy	Vallejo
	California State College-San Bernadino	San Bernardino
	California State College-Stanislaus	Turlock
	California Polytechnic State University-San Luis Obispo	San Luis Obispo
	California State University-Fresno	Fresno
	California State University-Fullerton	Fullerton
	California State University-Hayward	Hayward
	California State University-Long Beach	Long Beach
	California State University-Los Angeles	Los Angeles
	California State University-Sacramento	Sacramento
	San Diego State University	San Diego
	San Jose State University	San Jose
	Cerritos College	Norwalk
	Cerro Coso Community College	Ridgecrest
	Chapman College	Orange
	Christian Heritage College	El Cajon
	Church Divinity School of the Pacific	Berkeley
	Citrus College	Azusa
	Claremont Colleges-System Office	Claremont
	Claremont Men's College	Claremont
	Claremont University Center and Graduate School	Claremont
	Harvey Mudd College	Claremont
	Pitzer College	Claremont
	Pomona College	Claremont
	Scripps College	Claremont
	Coast Community College-System Office	Costa Mesa
	Golden West College	Huntington Beach
	Orange Coast College	Costa Mesa
	Cogswell College	San Francisco
	Colegio De La Tierra	Goshen
	College of the Canyons	Valencia
	College of the Desert	Palm Desert
	College of Marin	Kentfield
	College of Notre Dame	Belmont
	College of the Redwoods	Eureka
	College of the Siskiyous	Weed
	Columbia Junior College	Columbia
	Compton Community College	Compton
	Contra Costa Community College-System Office	
	Diablo Valley College	Pleasant Hill
	Cuesta College	San Luis Obispo
	Cypress College	Cypress
	Dominican College of San Rafael	San Rafael
	El Camino College	Torrance
	Foothill-De Anza Community College District-System Office	Los Altos Hills
	De Anza College	Cupertino
	Foothill College	Los Altos Hills
	Fuller Theological Seminary	Pasadena
	Gavilan College	Gilroy
	Glendale Community College	Glendale
	Golden Gate University	San Francisco
	Grossmont College	El Cajon
	Hartnell College	Salinas
	Holy Family College	Mission San Jose

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Holy Names College	Oakland
	Immaculate Heart College	Los Angeles
	Indian Valley Colleges	Novato
	John F. Kennedy University	Orinda
	Lake Tahoe Community College	S. Lake Tahoe
	Lassen College	Susanville
	LaVerne College	La Verne
	L.I.F.E. Bible College	Los Angeles
	Lincoln University	San Francisco
	Lone Mountain College	San Francisco
	Long Beach City College	Long Beach
	Los Angeles Baptist College	Newhall
	Los Angeles Community College-System Office	Los Angeles
	East Los Angeles College	Los Angeles
	Los Angeles City College	Los Angeles
	Los Angeles Harbor College	Wilmington
	Los Angeles Mission College	San Fernando
	Los Angeles Pierce College	Woodland Hills
	Los Angeles Southwest College	Los Angeles
	Los Angeles Valley College	Van Nuys
	West Los Angeles College	Culver City
	Los Rios Community College-System Office	Sacramento
	Cosumnes River College	Sacramento
	Sacramento City College	Sacramento
	Loyla Marymount University	Los Angeles
	Marymount Palos Verdes College	Rancho Palos Verdes
	Mendocino College	Ukiah
	Menlo College	Menlo Park
	Mennonite Brethren Biblical Seminary	Fresno
	Merced College	Merced
	Mills College	Oakland
	Monterey Institute for Foreign Studies	Monterey
	Monterey Peninsula College	Monterey
	Mount San Antonio College	Walnut
	Mount San Jacinto College	San Jacinto
	Napa College	Napa
	National University	San Diego
	New College of California	San Francisco
	Northrop University	Inglewood
	Occidental College	Los Angeles
	Ohlone College	Fremont
	Otis Art Institute of Los Angeles County	Los Angeles
	Pacific Christian College	Fullerton
	Pacific College	Fresno
	Pacific Oaks College	Pasadena
	Pacific School of Religion	Berkeley
	Pacific Union College	Angwin
	Palomar College	San Marcos
	Palo Verde College	Blythe
	Pasadena City College	Pasadena
	Patten Bible College	Oakland
	Pepperdine University	Malibu
	Peralta Community Colleges-System Office	Oakland
	College of Alameda	Alameda
	Point Loma College	San Diego
	Porterville College	Porterville
	Rand Graduate Institute of Policy Studies	Santa Monica
	Riverside City College	Riverside
	Rosemead Graduate School of Psychology	Rosemead
	Saddleback Community College	Mission Viejo
	Saint Mary's College of California	Moraga

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Saint Patrick's College	Mountain View
	San Diego Community College-Central Office	San Diego
	San Diego Community College-City College	San Diego
	San Diego Community College-Evening College	
	San Francisco Art Institute	San Francisco
	San Francisco Conservatory of Music	San Francisco
	San Francisco Theological Seminary	San Anselmo
	San Joaquin Delta College	Stockton
	San Jose Community College District-	
	Evergreen Valley College	San Jose
	San Jose City College	San Jose
	San Mateo County Community College District-System Office	San Mateo
	Canada College	Redwood City
	College of San Mateo	San Mateo
	Skyline College	San Bruno
	Santa Ana College	Santa Ana
	Santa Barbara City College	Santa Barbara
	Santa Monica College	Santa Monica
	Santa Rosa Junior College	Santa Rosa
	Shasta College	Redding
	Sierra College	Rocklin
	Simpson College	San Francisco
	Solano Community College	Suisun City
	Southern California College	Costa Mesa
	Southern California College of Optometry	Fullerton
	Southwestern University School of Law	Los Angeles
	Stanford University	Stanford
	State Center Community College District	
	Fresno City College	Fresno
	Reedley College	Reedley
	Taft College	Taft
	United States International University	San Diego
	University of California-Berkeley	Berkeley
	University of California-Davis	Davis
	University of California Hastings College of Law	San Francisco
	University of California-Irvine	Irvine
	University of California-Los Angeles	Los Angeles
	University of California-Riverside	Riverside
	University of California-San Francisco	San Francisco
	University of California-Santa Barbara	Santa Barbara
	University of the Pacific	Stockton
	University of Redlands	Redlands
	University of San Diego	San Diego
	University of San Francisco	San Francisco
	University of Santa Clara	Santa Clara
	University of Southern California	Los Angeles
	University of West Los Angeles	Culver City
	Ventura County Community College District	
	Moorpark College	Moorpark
	Oxnard College	Oxnard
	Ventura College	Ventura
	West Coast Bible College	Fresno
	West Coast University Central Office	Los Angeles
	West Coast University Orange County Center	Orange
	Western State University College of Law-Orange County	Fullerton
	Western State University College of Law-San Diego	San Diego
	West Hills College	Coalinga
	Westmont College	Santa Barbara
	West Valley College	Saratoga

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Whittier College	Whittier
	Woodbury University	Los Angeles
	The Wright Institute	Berkeley
	Yuba College	Marysville
CO	Adams State College	Alamosa
	Aims Community College	Greeley
	Arapahoe Community College	Littleton
	Colorado College	Colorado Springs
	Colorado Mountain College-East Campus	Leadville
	Colorado Mountain College-West Campus	Glenwood Springs
	Colorado School of Mines	Golden
	Colorado State University	Fort Collins
	Colorado Technical College	Manitou Springs
	Colorado Women's College	Denver
	Community College of Denver-Auraria Campus	Denver
	Community College of Denver-North Campus	Denver
	Community College of Denver-Red Rocks Campus	Golden
	Conservative Baptist Theological Seminary	Denver
	El Paso Community College	Colorado Springs
	Fort Lewis College	Durango
	Iliff School of Theology	Denver
	Lamar Community College	Lamar
	Loretto Heights College	Denver
	Mesa College	Grand Junction
	Metropolitan State College	Denver
	Morgan Community College	Fort Morgan
	Northeastern Junior College	Sterling
	Ortero Junior College	La Junta
	Regis College	Denver
	Rockmont College	Denver
	Saint Thomas Seminary	Denver
	Trinidad State Junior College	Trinidad
	University of Colorado-Boulder	Boulder
	University of Colorado-Colorado Springs	Colorado Springs
	University of Colorado-Denver	Denver
	University of Denver	Denver
	University of Denver College of Law	Denver
	University of Northern Colorado	Greeley
	University of Southern Colorado	Pueblo
	Western Bible College	Morrison
	Western State College of Colorado	Gunnison
CT	Albertus Magnus College	New Haven
	Annhurst College	Woodstock
	Bridgeport Engineering Institute	Bridgeport
	Connecticut College	New London
	Eastern Connecticut State College	Willimnatic
	Greater Hartford Community College	Hartford
	Hartford State Technical College	Hartford
	Housatonic Regional Community College	Bridgeport
	Mattuck Community College	Waterbury
	Middlesex Community College	Middletown
	Mitchell College	New London
	Mohegan Community College	Norwich
	Northwestern Connecticut Community College	Winsted
	Norwalk Community College	Norwald
	Post Junior College	Waterbury
	Quinebaug Valley Community College	Danielson
	Saint Joseph College	West Hartford

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Thames Valley State Technical College	Norwich
	Trinity College	Hartford
	Tunxis Community College	Farmington
	University of Bridgeport	Bridgeport
	University of Hartford	West Hartford
	University of New Haven	West Haven
	Yale University	New Haven
DE	Delaware State College	Dover
	Delaware Technical and Community College	Dover
	Goldey Beacom College	Wilmington
	University of Delaware	Newark
	Wesley College	Dover
DC	American University	Washington
	Catholic University of America	Washington
	District of Columbia Teachers College	Washington
	Gallaudet College	Washington
	George Washington University	Washington
	Howard University	Washington
	Mount Vernon College	Washington
	Trinity College	Washington
FL	Barry College	Miami
	Brevard Community College	Cocoa
	Broward Community College	Fort Lauderdale
	Central Florida Community College	Ocala
	Chipola Junior College	Marianna
	College of Boca Raton	Boca Raton
	Daytona Beach Community College	Daytona Beach
	Eckerd College	St. Petersburg
	Edison Community College	Fort Meyers
	Embry-Riddle Aeronautical University	Daytona Beach
	Flagler College	St. Augustine
	Florida A & M University	Tallahassee
	Florida Atlantic University	Boca Raton
	Florida College	Temple Terrace
	Florida International University	Miami
	Florida Junior College	Jacksonville
	Florida Keys Community College	Key West
	Florida Southern College	Lakeland
	Florida Technological University	Orlando
	Fort Lauderdale College	Fort Lauderdale
	Gulf Coast Community College	Panama City
	Heed University	Hollywood
	Hillsborough Community College	Tampa
	Indian River Community College	Fort Pierce
	Jacksonville University	Jacksonville
	Jones College	Jacksonville
	Lake City Community College	Lake City
	Lake-Sumter Community College	Leesburg
	Manatee Junior College	Bradenton
	Miami Christian College	Miami
	Miami-Dade Community College	Miami
	North Florida Junior College	Madison
	Nova University	Fort Lauderdale
	Okaloosa-Walton Junior College	Niceville
	Palm Beach Atlantic College	West Palm Beach
	Palm Beach Junior College	Lake Worth
	Pensacola Junior College	Pensacola
	Polk Community College	Winter Haven

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Rollins College	Winter Park
	Saint Johns River Junior College	Palatka
	Saint Leo College	Saint Leo
	Santa Fe Community College	Gainesville
	Seminole Community College	Sanford
	South-Eastern Bible College	Lakeland
	South Florida Junior College	Avon Park
	University of Florida	Gainesville
	University of Miami	Coral Gables
	University of North Florida	Jacksonville
	Warner Southern College	Lake Wales
	Webber College	Babson Park
GA	Abraham Baldwin Agricultural College	Tifton
	Agnes Scott College	Decatur
	Albany Area Vocational Technical School	Albany
	Albany Junior College	Albany
	Albany State College	Albany
	Andrew College	Cuthbert
	Armstrong State College	Savannah
	Atlanta Christian College	East Point
	Atlanta Junior College	Atlanta
	Atlanta University	Atlanta
	Augusta College	Augusta
	Bainbridge Junior College	Bainbridge
	Berry College	Mount Berry
	Brenau College	Gainesville
	Brewton-Parker College	Mount Vernon
	Carroll County Area Vocational-Technical School	Carrollton
	Carver Bible Institute and College	Atlanta
	Clark College	Atlanta
	Clayton Junior College	Morrow
	Columbus College	Columbus
	Dalton Junior College	Dalton
	DeKalb Community College	Clarkston
	Emanuel County Junior College	Swainsboro
	Emory University	Atlanta
	Fort Valley State College	Fort Valley
	Gainesville Junior College	Gainesville
	Georgia College	Milledgeville
	Georgia Institute of Technology	Atlanta
	Georgia Military College	Milledgeville
	Georgia Southern College	Statesboro
	Georgia Southwestern College	Americus
	Georgia State University	Atlanta
	Gordon Junior College	Barnesville
	Kennesaw Junior College	Marietta
	LaGrange College	LaGrange
	Macon Junior College	Macon
	Marietta-Cobb Area Vocational Technical School	Marietta
	Mercer University	Macon
	Mercer University in Atlanta	Atlanta
	Middle Georgia College	Cochran
	Morehouse College	Atlanta
	Moultrie Area Vocational-Technical School	Moultrie
	North Georgia College	Dahlonega
	North Georgia Technical and Vocational School	Clarkesville
	Oglethorpe College	Atlanta
	Pickens Area Vocational-Technical School	Jasper
	Piedmont College	Demorest
	Reinhardt College	Waleska

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Savannah Area Vocational Technical School	Savannah
	Savannah State College	Savannah
	Shorter College	Rome
	South Georgia College	Douglas
	South Georgia Technical and Vocational School	Americus
	Southern Technical Institute	Marietta
	Swainsboro Area Vocational-Technical School	Swainsboro
	Thomas Area Vocational-Technical School	Thomasville
	Tift College	Forsyth
	Toccoa Falls College	Toccoa Falls
	Troup County Area Vocational Technical School	LaGrange
	Truett McConnell College	Cleveland
	University of Georgia	Athens
	Upson County Area Vocational-Technical School	Thomaston
	Valdosta State College	Valdosta
	Valdosta Technical School	Valdosta
	Walker County Area Technical School	Rock Spring
	Waycross-Ware Area Technical School	Waycross
	Wesleyan College	Macon
	West Georgia College	Carrollton
	Young Harris College	Young Harris
HI	Brigham Young University-Hawaii Campus	Laie Oahu
	Chaminade College of Honolulu	Honolulu
	Hawaii Pacific College	Honolulu
	University of Hawaii- Honolulu Community College	Honolulu
	University of Hawaii- Kapiolani Community College	Honolulu
	University of Hawaii- Kauai Community College	Linue
	University of Hawaii- Leeward Community College	Pearl City
	University of Hawaii-Manoa	Honolulu
	University of Hawaii- Maui Community College	Kahului
	University of Hawaii- Windward Community College	Kaneohe
ID	Boise State University	Boise
	College of Southern Idaho	Twin Falls
	Idaho State University	Pocatello
	North Idaho College	Coeur D'Alene
	Northwest Nazarene College	Nampa
	Ricks College	Rexburg
	University of Idaho	Moscow
IL	Augustana College	Rock Island
	Aurora College	Aurora
	Barat College	Lake Forest
	Belleville Area College	Belleville
	Blackburn College	Carlinville
	Black Hawk College	Moline
	Bradley University	Peoria
	Carl Sandburg College	Galesburg
	Central YMCA Community College	Chicago
	Chicago College of Osteopathic Medicine	Chicago
	Chicago State University	Chicago
	College of DuPage	Glen Ellyn

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	College of Lake County	Grayslake
	College of St. Francis	Joliet
	College of the University of Chicago	Chicago
	Danville Junior College	Danville
	DeLourdes College	Des Plaines
	DePaul University	Chicago
	DeVry Institute of Technology	Chicago
	Eastern Illinois University	Charleston
	Elgin Community College	Elgin
	Elmhurst College	Elmhurst
	Eureka College	Eureka
	George Williams College	Downers Grove
	Governors State University	Park Forest South
	Greenville College	Greenville
	Highland Community College	Freeport
	Illinois Benedictine College	Lisle
	Illinois Central College	East Peoria
	Illinois College	Jacksonville
	Illinois College of Optometry	Chicago
	Illinois College of Podiatric Medicine	Chicago
	Illinois Institute of Technology	Chicago
	Illinois State University	Normal
	Illinois Valley Community College	Oglesby
	Illinois Wesleyan University	Bloomington
	Joliet Junior College	Joliet
	Judson College	Elgin
	Kankakee Community College	Kankakee
	Kendall College	Evanston
	Kishwaukee College	Malta
	Knox College	Galesburg
	Lake Forest College	Evanston
	Lakeland College	Mattoon
	Lewis and Clark Community College	Godfrey
	Lincoln Trail College	Robinson
	Logan (John A.) College	Carterville
	Loyola University of Chicago	Chicago
	MacMurray College	Jacksonville
	McHenry County College	Crystal Lake
	McKendree College	Lebanon
	Meadville Theological School	Lombard
	Millikin University	Decatur
	Moraine Valley Community College	Palos Hills
	National College of Chiropractic	Lombard
	North Central College	Naperville
	Northeastern Illinois University	Chicago
	Northern Baptist Theological Seminary	Lombard
	Northern Illinois University	DeKalb
	Northwestern University	Evanston
	Oakton Community College	Morton Grove
	Olivet Nazarene College	Kankakee
	Olney Central College	Mt. Carmel
	Prairie State Community College	Chicago Heights
	Rockford College	Rockford
	Rock Valley College	Rockford
	Roosevelt University	Chicago
	Rush University, College of Nursing and Allied Health Sciences	Chicago
	Rush University, Rush Medical College	Chicago
	Sangamon State University	Springfield
	Sauk Valley College	Dixon
	Southern Illinois University	Carbondale
	Southern Illinois University	Edwardsville
	Spertus College of Judaica	Chicago
	Spoon River College	Canton
	Springfield College in Illinois	Springfield

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	State Community College of East Saint Louis, Illinois	East St. Louis
	Thornton Community College	South Holland
	Triton College	River Grove
	University of Health Sciences, The Chicago Medical School	Chicago
	University of Illinois at Chicago Circle	Chicago
	University of Illinois at the Medical Center, School of Public Health	Chicago
	University of Illinois at Urbana-Champaign	Urbana-Champaign
	Wabash Valley College	Mt. Carmel
	Waubonsee Community College	Sugar Grove
	Western Illinois University	Macomb
	Wheaton College	Wheaton
	William Rainey Harper College	Palatine
IN	Anderson College	Anderson
	Associated Mennonite Biblical Seminary	Elkhart
	Ball State University	Muncie
	Bethel College	Mishawaka
	Butler University	Indianapolis
	DePauw University	Greencastle
	Earlham College	Richmond
	Franklin College	Franklin
	Goshen College	Goshen
	Grace College	Winona Lake
	Hanover College	Hanover
	Holy Cross Junior College	Notre Dame
	Huntington College	Huntington
	Indiana Central College	Indianapolis
	Indiana Institute of Technology	Fort Wayne
	Indiana State University	Evansville
	Indiana University	Bloomington
	Indiana University-East	Richmond
	Indiana University-Kokomo	Kokomo
	Indiana University-Northwest	Gary
	Indiana University-South Bend	South Bend
	Indiana University-Southeast	New Albany
	Indiana University-Purdue University at Fort Wayne	Fort Wayne
	Indiana Vocational Technical College	Indianapolis
	International Junior College	Fort Wayne
	Manchester College	North Manchester
	Marian College	Indianapolis
	Marion College	Marion
	Oakland College	Oakland City
	Purdue State University	Muncie
	Purdue University	West Lafayette
	Purdue University-Calumet	Calumet
	Purdue University-North Central	Westville
	Rose-Hulman Institute of Technology	Terre Haute
	Saint Joseph's College	Rensselaer
	Saint Mary's College	Notre Dame
	Saint Mary of the Woods College	Saint Mary of the Woods
	Saint Meinard College	St. Meinard
	Taylor University	Upland
	Tri-State University	Angola
	University of Evansville	Evansville
	University of Notre Dame	South Bend
	Valparaiso University	Valparaiso
	Vincennes University	Vincennes
	Wabash College	Crawfordsville

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
IA	Area One Vocational-Technical School	Calmar and Dubuque
	Briar Cliff College	Sioux City
	Central College	Pella
	Clarke College	Dubuque
	Coe College	Cedar Rapids
	Cornell College	Mt. Vernon
	Des Moines Area Community College	Ankeny
	Drake University	Des Moines
	Ellsworth Community College	Iowa Falls
	Grinnell College	Grinnell
	Hawkeye Institute of Technology	Waterloo
	Iowa Central Community College	Fort Dodge
	Iowa Lakes Community College	Estherville
	Iowa State University	Ames
	Iowa Wesleyan College	Mount Pleasant
	Iowa Western Community College	Council Bluffs
	Kirkwood Community College	Cedar Rapids
	Loras College	Dubuque
	Luther College	Decorah
	Marshalltown Community College	Marshalltown
	Marycrest College	Davenport
	Morningside College	Sioux City
	Mount Mercy College	Cedar Rapids
	North Iowa Area Community College	Mason City
	Open Bible College	Des Moines
	Palmer College of Chiropractic	Davenport
	Simpson College	Indianola
	Southeastern Community College	Burlington
	Southwestern Community College	Creston
	University of Dubuque	Dubuque
	University of Dubuque Theological Seminary	Dubuque
	University of Iowa	Iowa City
	University of Northern Iowa	Cedar Falls
	Upper Iowa University	Fayette
	Wartburg College	Waverly
	Wartburg Seminary	Dubuque
	Westmar College	LeMars
	Western Iowa Technical Community College	Sioux City
KS	Allen County Community Junior College	Iola
	Baker University	Baldwin
	Barton County Community College	Great Bend
	Benedictine College	Atchison
	Bethel College	North Newton
	Central College	McPherson
	Cloud County Community College	Concordia
	Coffeyville Community Junior College	Coffeyville
	Colby Community College	Colby
	Cowley County Community College	Arkansas City
	Dodge City Community College	Dodge City
	Donnelly College	Kansas City
	Emporia Kansas State College	Emporia
	Fort Hays Kansas State College	Hays
	Fort Scott Community College	Fort Scott
	Friends Bible College	Haviland
	Garden City Community College	Garden City
	Haskell Indian Junior College	Lawrence
	Hesston College	Hesston
	Highland Community Junior College	Highland
	Hutchinson Community Junior College	Hutchinson
	Independence Community Junior College	Independence
	Johnson County Community College	Overland Park
	Kansas City Community College	Kansas City

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Kansas Newman College	Wichita
	Kansas State College of Pittsburg	Pittsburg
	Kansas State University	Manhattan
	Kansas Technical Institute	Salina
	Kansas Wesleyan	Salina
	Labette Community Junior College	Parsons
	Manhattan Christian College	Manhattan
	Marymount College of Kansas	Salina
	McPherson College	McPherson
	Mid-America Nazarene College	Olathe
	Neosho County Community Junior College	Chanute
	Ottawa University	Ottawa
	Pratt Community College	Pratt
	Saint John's College	Winfield
	Saint Mary College	Leavenworth
	Saint Mary of the Plains College	Dodge City
	Seward County Community College	Liberal
	Southwestern College in Kansas	Winfield
	Sterling College	Sterling
	Tabor College	Hillsboro
	The University of Kansas	Lawrence
	Washburn University of Topeka	Topeka
	Wichita State University	Wichita
KY	Alice Lloyd College	Pippa Passes
	Asbury College	Wilmore
	Bellarmine College	Louisville
	Berea College	Berea
	Brescia College	Owensboro
	Campbellsville College	Campbellsville
	Centre College of Kentucky	Danville
	Cumberland College	Williamsburg
	Eastern Kentucky University	Richmond
	Georgetown College	Georgetown
	Jefferson Vocational Regional Office	Jeffersontown
	Kentucky Christian College	Grayson
	Kentucky State University	Frankfort
	Kentucky Wesleyan College	Owensboro
	Lees Junior College	Jackson
	Lindsey Wilson College	Columbia
	Midway College	Midway
	Morehead State University	Morehead
	Murray State University	Murray
	Pikeville College	Pikeville
	Saint Catharine College	Saint Catharine
	Southeastern Christian College	Winchester
	Sue Bennett College	London
	Thomas More College	Fort Mitchell
	Transylvania University	Lexington
	University of Kentucky	Lexington
	University of Kentucky Community College System	Lexington
	University of Louisville	Louisville
	Western Kentucky University	Bowling Green
LA	Bossier Parish Community College	Bossier City
	Centenary College of Louisiana	Shreveport
	Delgado College	New Orleans
	Dillard University	New Orleans
	Grambling State University	Grambling
	Louisiana State University-Central Office	Baton Rouge

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Louisiana State University and Agricultural and Mechanical College at Baton Rouge	Baton Rouge
	Louisiana State University-Alexandria	Alexandria
	Louisiana State University-Eunice	Eunice
	Louisiana State University-Shreveport	Shreveport
	University of New Orleans	New Orleans
	Louisiana Tech University	Ruston
	McNeese State University	Lake Charles
	New Orleans Baptist Theological Seminary	New Orleans
	Northeast Louisiana University	Monroe
	Northwestern State University of Louisiana	Natchitoches
	Notre Dame Seminary School of Theology	New Orleans
	Our Lady of Holy Cross College	New Orleans
	Saint Bernard Parish Community College	Chalmette
	Saint Joseph Seminary College	Saint Benedict
	Saint Mary's Dominican College	New Orleans
	Southern University in New Orleans	New Orleans
	Tulane University of Louisiana	New Orleans
	Xavier University of Louisiana	New Orleans
ME	Bowdoin College	Brunswick
	Colby College	Waterville
	College of the Atlantic	Bar Harbor
	Eastern Maine Vocational and Technical Institute	Bangor
	Maine Maritime Academy	Castine
	Masson College	Springvale
	South Maine Vocational and Technical Institute	South Portland
	Unity College	Unity
	University of Maine at Orono	Orono
MD	Bowie State College	Bowie
	Catonsville Community College	Catonsville
	Charles County Community College	La Plata
	Chesapeake College	Wye Mills
	Columbia Union College	Takoma Park
	Community College of Baltimore	Baltimore
	Dundalk Community College	Baltimore
	Essex Community College	Baltimore County
	Garrett Community College	McHenry
	Goucher College	Towson
	Hagerstown Junior College	Hagerstown
	Harford Community College	Bel Air
	Hood College	Frederick
	Howard Community College	Columbia
	Johns Hopkins University	Baltimore
	Loyola College	Baltimore
	Montgomery College	Rockville
	Saint John's College	Annapolis
	Saint Mary's College of Maryland	Saint Mary's City
	Towson State College	Baltimore
	University of Baltimore	Baltimore
	University of Maryland	College Park
	Villa Julie College	Stevenson
	Washington College	Chestertown

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
MA	Amherst College	Amherst
	Anna Maria College	Paxton
	Assumption College	Worcester
	Bay Path Junior College	Longmeadow
	Bentley College	Waltham
	Boston College	Chestnut Hill
	Boston University	Boston
	Gordon College	Wenham
	Hampshire College	Amherst
	Harvard University	Cambridge
	Lasell Junior College	Auburndale
	Lesley College	Cambridge
	Massachusetts Institute of Technology	Cambridge
	Merrimack College	North Andover
	Mount Holyoke College	South Hadley
	Nichols College	Dudley
	Northeastern University	Boston
	Regis College	Weston
	Simon's Rock	Great Barrington
	Smith College	Northampton
	Southeastern Massachusetts University	North Darmouth
	Springfield College	Springfield
	Springfield Technical Community College	Springfield
	Stonehill College	North Easton
	Suffolk University	Boston
	Tufts University	Medford
	University of Massachusetts	Boston
	Wentworth Institute	Boston
	Wheelock College	Boston
	Williams College	Williamstown
	Worcester Junior College	Worcester
	Worcester Polytechnic Institute	Worcester
MI	Alma College	Alma
	Alpena Community College	Alpena
	Andrews University	Berrien Springs
	Aquinas College	Grand Rapids
	Bay de Noc Community College	Escanaba
	Calvin College	Grand Rapids
	Calvin Theological Seminary	Grand Rapids
	Central Michigan University	Mount Pleasant
	Concordia Lutheran Junior College	Ann Arbor
	Delta College	University Center
	Detroit Institute of Technology	Detroit
	Eastern Michigan University	Ypsilanti
	Ferris State College	Big Rapids
	General Motors Institute	Flint
	Grace Bible College	Wyoming
	Grand Rapids Baptist College	Grand Rapids
	Grand Rapids Junior College	Grand Rapids
	Grand Valley State College	Allendale
	Highland Park Community College	Highland Park
	Hillsdale College	Hillsdale
	Hope College	Holland

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Jackson Community College	Jackson
	Kalamazoo College	Kalamazoo
	Kalamazoo Valley Community College	Kalamazoo
	Kirtland Community College	Roscommon
	Lake Michigan College	Benton Harbor
	Lake Superior State College	Saulte Ste. Marie
	Lansing Community College	Lansing
	Macomb County Community College	Warren
	Madonna College	Livonia
	Marygrove College	Detroit
	Mercy College of Detroit	Detroit
	Merrill-Palmer Institute	Detroit
	Michigan Department of Education-Environmental Guidelines	Lansing
	Michigan State University	East Lansing
	Michigan Technological University	Houghton
	Mid Michigan Community College	Harrison
	Monroe County Community College	Monroe
	Montcalm Community College	Sidney
	Mott Community College	Flint
	Muskegon Business College	Muskegon
	Muskegon Community College	Muskegon
	Northern Michigan University	Marquette
	Northwestern Michigan College	Traverse City
	Oakland Community College	Bloomfield Hills
	Oakland University	Rochester
	Olivet College	Olivet
	Saginaw Valley State College	University Center
	Saint Mary's College	Orchard Lake
	Schoolcraft College	Livonia
	Shaw College at Detroit	Detroit
	Southwestern Michigan College	Dowagiac
	Spring Arbor College	Spring Arbor
	Suomi College	Hancock
	University of Detroit	Detroit
	University of Michigan	Ann Arbor
	Walsh College	Troy
	Washtenaw Community College	Ann Arbor
	Wayne County Community College	Detroit
	Wayne State University	Detroit
	Western Michigan University	Kalamazoo
	West Shore Community College	Scottville
	Western Theological Seminary	Holland
MN	Anoka-Ramsey Community College	Coon Rapids
	Augsburg College	Minneapolis
	Austin Community College	Austin
	Bemidji State University	Bemidji
	Bethany Lutheran College	Mankato
	Brainerd Community College	Brainerd
	Carleton College	Northfield
	College of Saint Benedict	St. Joseph
	College of St. Catherine	St. Paul
	College of St. Scholastica	Duluth
	College of St. Thomas	St. Paul
	Concordia College	Moorhead
	Crosier Seminary Junior College	Onamia
	Dr. Martin Luther College	New Ulm
	Fergus Falls Community College	Fergus Falls
	Hibbing Community College	Hibbing
	Itasca Community College	Grand Rapids
	Lakewood Community College	White Bear Lake
	Luther Theological Seminary	St. Paul
	Macalester College	St. Paul
	Mankato State University	Mankato

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Mesabi Community College	Virginia
	Metropolitan Community College	Minneapolis
	Metropolitan State University	St. Paul
	Minneapolis College of Art and Design	Minneapolis
	Minnesota Bible College	Rochester
	Moorhead State College	Moorhead
	Normandale Community College	Bloomington
	North Hennepin Community College	Minneapolis
	Northland Community College	Thief River Falls
	Northwestern College	Roseville
	Rainy River Community College	International Falls
	Rochester Community College	Rochester
	Saint John's University	Collegeville
	Saint Mary's College	Winona
	Southwest Minnesota State College	Marshall
	St. Cloud Area Vocational Technical Institute	St. Cloud
	St. Cloud State University	St. Cloud
	St. Mary's Junior College	Minneapolis
	St. Paul Bible College	Bible College
	United Theological Seminary of the Twin Cities	New Brighton
	University of Minnesota	Minneapolis
	Vermilion Community College	Ely
	William Mitchell College of Law	St. Paul
	Winona State University	Winona
	Worthington Community College	Worthington
MS	Alcorn State University	Lorman
	Belhaven College	Jackson
	Clarke College	Newton
	Coahama Junior College	Clarksdale
	Copiah-Lincoln Junior College	Wesson
	Delta State University	Cleveland
	East Central Junior College	Decatur
	East Mississippi Junior College	Scooba
	Hinds Junior College	Raymond
	Holmes Junior College	Goodman
	Itawamba Junior College	Fulton
	Jackson State University	Jackson
	John C. Stennis Vocational Complex	Dekalb
	Jones County Junior College	Ellisville
	Mary Holmes College	West Point
	Meridian Junior College	Meridian
	Millsaps College	Jackson
	Mississippi College	Clinton
	Mississippi Delta Junior College	Moorhead
	Mississippi Gulf Coast Junior College	Perkinston
	Mississippi Industrial College	Holly Springs
	Mississippi State University	Mississippi State
	Mississippi University for Women	Columbus
	Northeast Mississippi Junior College	Booneville
	Northwest Mississippi Junior College	Senatobia
	Pearl River Junior College	Poplarville
	Rust College	Holly Springs
	Southwest Mississippi Junior College	Summit
	Tougaloo College	Tougaloo
	University of Mississippi	University
	University of Mississippi Medical Center	Jackson
	University of Southern Mississippi	Hattiesburg
	Utica Junior College	Utica
	Wesley College	Florence
	William Carey College	Hattiesburg
	Wood Junior College	Mathiston

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
MO	Assemblies of God Graduate School	Springfield
	Avila College	Kansas City
	Calvary Bible College	Kansas City
	Central Bible College	Springfield
	Central Methodist College	Fayette
	Central Missouri State University	Warrensburg
	Columbia College	Columbia
	Concordia Seminary	St. Louis
	Cottey College	Nevada
	Crowder College	Neosho
	Culver-Stockton College	Canton
	Fontbonne College	St. Louis
	Hannibal Lagrange College	Hannibal
	Harris Teachers College	St. Louis
	Jefferson College	Hillsboro
	Kansas City Art Institute	Kansas City
	Kansas City College of Osteopathic Medicine	Kansas City
	Logan College of Chiropractic	Chesterfield
	Longview Community College	Kansas City
	Maple Woods Community College	Kansas City
	Maryville College	St. Louis
	Meramec Community College	St. Louis
	Missouri Baptist College	St. Louis
	Missouri Southern State College	Joplin
	Moberly Area Junior College	Moberly
	Northeast Missouri State University	Kirksville
	Northwest Missouri State University	Maryville
	Rockhurst College	Kansas City
	Saint Louis College of Pharmacy	St. Louis
	Saint Louis Community College at Forest Park	St. Louis
	Saint Louis University	St. Louis
	Saint Paul's College	Concordia
	School of the Ozarks	Point Lookout
	Southwest Missouri State University	Springfield
	State Fair Community College	Sedalia
	Stephen's College	Columbia
	Tarkio College	Tarkio
	The Principia	St. Louis
	Three Rivers Community College	Poplar Bluff
	University of Missouri-Columbia	Columbia
	University of Missouri-Kansas City	Kansas City
	University of Missouri-Rolla	Rolla
	University of Missouri-St. Louis	St. Louis
	Washington University	St. Louis
	Water and Wastewater Technical School	Neosho
	Webster College	Webster
	Westminster College	Fulton
	William Jewell College	Kansas City
MT	Carroll College	Helena
	College of Great Falls	Great Falls
	Dawson College	Glendive
	Eastern Montana College	Billings
	Flathead Valley Community College	Kalispell
	Miles Community College	Miles City
	Montana College of Mineral Science and Technology	Butte
	Montana State University	Bozeman
	Northern Montana College	Havre
	Rocky Mountain College	Billings
	University of Montana	Missoula
	Western Montana College	Dillon

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
NE	Central Technical Community College	Hastings
	Chadron State College	Chadron
	College of Saint Mary	Omaha
	Concordia College	Seward
	Creighton University	Omaha
	Dana College	Blair
	Doane College	Crete
	Grace College of the Bible	Omaha
	Hastings College	Hastings
	Kearney State College	Kearney
	McCook Community College	McCook
	Midland Lutheran College	Fremont
	Mid-Plains Community College	North Platte
	Northeast Technical Community College	Norfolk
	Platte Technical Community College	Columbus
	Southeast Community College	Lincoln
	Union College	Lincoln
	University of Mid-America	Lincoln
	University of Nebraska	Lincoln
	Wayne State College	Wayne
NV	University of Nevada-Las Vegas	Las Vegas
	University of Nevada-Reno	Reno
	Clark County Community College	Las Vegas
	Northern Nevada Community College	Elko
	Sierra Nevada College	Incline Village
	Western Nevada Community College	Carson City
NH	Colby-Sawyer College	New London
	Dartmouth College	Hanover
	Franklin Pierce College	Rindge
	New England College	Henniker
	NH Technical Institute	Concord
	NH Voc-Tech College of Berlin	Berlin
	NH Voc-Tech College of Claremont	Claremont
	NH Voc-Tech College of Laconia	Laconia
	NH Voc-Tech College of Manchester	Manchester
	NH Voc-Tech College of Nashua	Nashua
	NH Voc-Tech College of Portsmouth	Portsmouth
	Saint Anselm's College	Manchester
	University of New Hampshire	Durham
	White Pines College	Chester
NJ	Atlantic Community College	Mays Landing
	Bergen Community College	Paramus
	Brookdale Community College	Lincroft
	Burlington County College	Penberton
	Camden County College	Caldwell
	Centenary College for Women	Hackettstown
	County College of Morris	Dover
	Cumberland County College	Vineland
	Drew University	Madison
	Fairleigh Dickinson University	Rutherford
	Gloucester County College	Sewell
	Kean College of New Jersey	Union
	Mercer County Community College	Trenton
	Middlesex County College	Edison
	Montclair State College	Upper Montclair
	New Jersey Institute of Technology	Newark
	Ocean County College	Toms River
	Passaic County Community College	Paterson
	Princeton University	Princeton

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Rider College	Trenton
	Rutgers the State University	New Brunswick
	Stevens Institute of Technology	Hoboken
	Trenton State College	Trenton
	Union College	Cranford
	Union County Technical Institute	Scotch Plains
	William Paterson College	Wayne
NM	College of the Southwest	Hobbs
	Eastern New Mexico University-Main Campus	Portales
	Eastern New Mexico University-Roswell	Roswell
	New Mexico Highlands University	Las Vegas
	New Mexico Institute of Mining and Technology	Socorro
	New Mexico Junior College	Hobbs
	New Mexico Military Institute	Roswell
	New Mexico State University-Las Cruces	Las Cruces
	New Mexico State University-San Juan	San Juan
	University of Albuquerque	Albuquerque
	University of New Mexico-Main Campus	Albuquerque
NY	Adelphi University	Garden City
	Albany College Pharmacy	Albany
	Albany Law School	Albany
	Alfred University	Alfred
	Bard College	Annandale-on-Hudson
	Bronx Community College	Bronx
	Brooklyn Law School	Brooklyn
	Canisius	Buffalo
	City University of New York	New York
	Clarkson College of Technology	Potsdam
	Colgate University	Hamilton
	College of Mt. Saint Vincent	Riverdale
	College of Saint Rose	Albany
	Columbia University	New York
	Concordia College	Bronxfille
	Cornell University	Ithaca
	Dowling College	Oakdale Long Island
	D'Youville College	Buffalo
	Erie Community College	Buffalo
	Hamilton College	Clinton
	Hartwick College	Oneonta
	Hilbert College	Hamburg
	Hobart-William Smith Colleges	Geneva
	Hofstra University	Hempstead
	Houghton College	Houghton
	Hudson Valley Community College	Troy
	Hunter College	New York
	Ithaca College	Ithaca
	King's College	Briarcliff Manor
	Long Island University	Greenvale
	Manhattan College	Bronx
	Medaille College	Buffalo
	Mercy College	Dobbs Ferry
	Molloy College	Rockville Centre
	New School for Social Research	New York
	New York Institute of Technology	Old Westbury
	New York Law School	New York
	Niagara University	Niagara University

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Paul Smith's College of Arts & Science	Paul Smiths
	Polytechnic Institute of New York	Brooklyn
	Rensselaer Polytechnic Institute	Troy
	Roberts Wesleyan College	Rochester
	Rochester Institute of Technology	Rochester
	Rockefeller University	New York
	Saint Banaventure University	Saint Bonaventure
	Saint John Fisher College	Rochester
	Saint John's University	Jamaica
	Saint Lawrence University	Canton
	Saint Thomas Aquinas College	Sparkhill
	Skidmore College	Saratoga Springs
	Southampton College	Southampton
	State University of New York at Buffalo	Buffalo
	Syracuse University	Syracuse
	The Cooper Union	New York
	Trocaire College	Buffalo
	Ulster County Community College	Stone Ridge
	University of Rochester	Rochester
	Vassar College	Poughkeepsie
	Wagner College	Staten Island
	Webb Institute of Naval Architecture	Glen Cove
	Westchester Community College	Valhalla
NC	Anson Technical Institute	Ansonville
	Appalachian State University	Boone
	Asheville Buncombe Technical Institute	Asheville
	Atlantic Christian College	Wilson
	Beaufort County Technical Institute	Washington
	Belmont Abbey College	Belmont
	Bennett College	Greensboro
	Bladen Technical Institute	Dublin
	Blue Ridge Technical Institute	Flat Rock
	Brevard College	Brevard
	Campbell College	Buies Creek
	Cape Fear Technical Institute	Wilmington
	Carteret Technical Institute	Morehead City
	Catawba College	Salisbury
	Catawba Valley Technical Institute	Hickory
	Central Carolina Technical Institute	Sanford
	Central Piedmont Community College	Charlotte
	Chowan College	Murfreesboro
	Cleveland County Technical Institute	Shelby
	Coastal Carolina Community College	Jacksonville
	College of the Albemarle	Elizabeth City
	Craven Community College	New Bern
	Davidson College	Davidson
	Davidson County Community College	Lexington
	Duke University	Durham
	Durham College	Durham
	East Carolina University	Greenville
	Elon College	Elon College
	Fayetteville State University	Fayetteville
	Fayetteville Technical Institute	Fayetteville
	Gardner Webb College	Boiling Springs
	Gaston College	Dallas
	Greensboro College	Greensboro
	Guilford College	Greensboro
	Guilford Technical Institute	Jamestown
	Halifax Community College	Weldon
	Haywood Technical Institute	Clyde
	High Point College	High Point
	Isothermal Community College	Spindale
	James Sprunt Institute	Kenansville
	Johnson C. Smith University	Charlotte

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Johnston Technical Institute	Smithfield
	Lees-McCrae College	Banner Elk
	Lenoir Community College	Kinston
	Lenoir-Rhyne College	Hickory
	Livingstone College	Salisbury
	Louisburg College	Louisburg
	Mars Hill College	Mars Hill
	Martin Community College	Williamston
	Mayland Technical Institute	Spruce Pine
	McDowell Technical Institute	Marion
	Meredith College	Raleigh
	Methodist College	Fayetteville
	Montreat-Anderson College	Montreat
	Mount Olive College	Mount Olive
	Nash Technical Institute	Rocky Mount
	North Carolina Agricultural and Technical State University	Greensboro
	North Carolina Central University	Durham
	North Carolina State University	Raleigh
	North Carolina Wesleyan College	Rocky Mount
	Pembroke State University	Pembroke
	Pfeiffer College	Misenheimer
	Piedmont Bible College	Winston-Salem
	Piedmont Technical Institute	Roxboro
	Pitt Technical Institute	Greenville
	Queens College	Charlotte
	Randolph Technical Institute	Asheboro
	Richmond Technical Institute	Hamlet
	Roanoke-Chowan Technical Institute	Ahoskie
	Robeson Technical Institute	Lumberton
	Rockingham Community College	Wentworth
	Rowan Technical Institute	Salisbury
	Saint Andrews Presbyterian College	Laurinburg
	Saint Augustine's College	Raleigh
	Saint Mary's College	Raleigh
	Salem College	Winston-Salem
	Sampson Technical Institute	Clinton
	Sandhills Community College	Carthage
	Shaw University	Raleigh
	Stanly Technical Institute	Albermarle
	Surry Community College	Dobson
	Technical Institute of Alamance	Burlington
	Tri-County Technical Institute	Murphy
	University of North Carolina at Chapel Hill	Chapel Hill
	University of North Carolina at Charlotte	Charlotte
	University of North Carolina at Greensboro	Greensboro
	University of North Carolina at Wilmington	Wilmington
	Wake Forest University	Winston-Salem
	Wake Technical Institute	Raleigh
	Warren Wilson College	Swannanoa
	Wayne Community College	Goldsboro
	Western Carolina University	Cullowhee
	Western Piedmont Community College	Morganton
	Wilkes Community College	Wilkesboro
	Wilson County Technical Institute	Wilson
	Wingate College	Wingate
	Winston-Salem State University	Winston-Salem

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
ND	Bismarck Junior College	Bismarck
	Dickinson State College	Dickinson
	Jamestown College	Jamestown
	Lake Region Junior College	Devils Lake
	Mary College	Bismarck
	Mayville State College	Mayville
	Minot State College	Minot
	North Dakota State School of Science	Wahpeton
	North Dakota State University-Main Campus	Fargo
	North Dakota State University-Bottineau	Bottineau
	Trinity Bible Institute	Ellendale
	University of North Dakota-Main Campus	Grand Forks
	University of North Dakota-Williston	Williston
OH	Antioch College	Yellow Springs
	Art Academy of Cincinnati	Cincinnati
	Bluffton College	Bluffton
	Capital University	Columbus
	Case Western Reserve University	Cleveland
	Central Ohio Technical College	Newark
	Central State University	Wilberforce
	Cincinnati Bible College	Cincinnati
	Cincinnati Technical College	Cincinnati
	Clark Technical College	Springfield
	Cleveland Institute of Art	Cleveland
	Cleveland Institute of Music	Cleveland
	Cleveland State University	Cleveland
	College of Mount St. Joseph on the Ohio	Cincinnati
	College of Steubenville	Steubenville
	College of Wooster	Wooster
	Columbus College of Art and Design	Columbus
	Columbus Technical Institute	Columbus
	Cuyahoga Community College	Cleveland
	Davis Junior College	Toledo
	Defiance College	Defiance
	Denison University	Granville
	Franklin University	Columbus
	Hebrew Union College	Cincinnati
	Heidelberg College	Tiffin
	Hiram College	Hiram
	Hocking Technical College	Nelsonville
	Jefferson County Technical Institute	Steubenville
	John Carroll University	Cleveland
	Josephinum College of Liberal Arts	Worthington
	Kent State University	Kent
	Kenyon College	Gambier
	Kettering College of Medical Arts	Kettering
	Lakeland Community College	Mentor
	Lima Technical College	Lima
	Lorain County Community College	Elyria
	Lutheran Theological Seminary	Columbus
	Malone College	Canton
	Marietta College	Marietta
	Marion Technical College	Marion
	Medical College of Ohio	Toledo
	Miami-Jacobs Junior College	Dayton
	Miami University	Oxford
	Mount Union College	Alliance
	Mount Vernon Nazarene College	Mount Vernon
	Muskingum Area Technical College	Zanesville
	Muskingum College	New Concord
	National Training and Operational Technology Center (EPA)	Cincinnati
	North Central Technical College	Mansfield

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Northwest Technical College	Archbold
	Notre Dame College	Cleveland
	Oberlin College	Oberlin
	Ohio Board of Regents-Technical Education Offerings	Columbus
	Ohio Dominican College	Columbus
	Ohio Northern University	Ada
	Ohio State University	Columbus
	Ohio University	Athens
	Ohio Wesleyan University	Delaware
	Owens Technical College	Perrysburg
	Saint John College of Cleveland	Cleveland
	Sinclair Community College	Dayton
	Stark Technical College	Canton
	Tiffin University	Tiffin
	United Theological Seminary	Dayton
	University of Cincinnati	Cincinnati
	University of Dayton	Dayton
	University of Toledo	Toledo
	Urbana College	Urbana
	Washington Technical College	Marietta
	Wittenberg University	Springfield
	Wright State University	Dayton
	Xavier University	Cincinnati
	Youngstown State University	Youngstown
OK	Bacone College	Muskogee
	Bartlesville Weslyan College	Bartlesville
	Bethany Nazarene College	Bethany
	Cameron University	Lawton
	Carl Albert Junior College	Poteau
	Central State University	Edmond
	Claremore Junior College	Claremore
	Connors State College	Warner
	East Central Oklahoma State University	Ada
	Eastern Oklahoma State College	Wilburton
	El Reno Junior College	El Reno
	Hillsdale Free Will Baptist College	Moore
	Midwest Christian College	Oklahoma City
	Murray State College	Tishomingo
	Northeastern Oklahoma Agricultural and Mechanical College	Miami
	Northeastern Oklahoma State University	Tahlequah
	Northern Oklahoma College	Tonkawa
	Northwesterm Oklahoma State University	Alva
	Oklahoma Baptist University	Shawnee
	Oklahoma Christian College	Oklahoma City
	Oklahoma City University	Oklahoma City
	Oklahoma Panhandle State University	Goodwell
	Oklahoma School of Business, Accountancy, Law and Finance	Tulsa
	Oklahoma State University-Main Campus	Stillwater
	Oklahoma State University-Oklahoma City	Oklahoma City
	Oral Roberts University	Tulsa
	Oscar Rose Junior College	Midwest City
	Phillips University	Enid
	Saint Gregory's College	Shawnee
	Sayre Junior College	Sayre
	Seminole Junior College	Seminole
	Southeastern Oklahoma State University	Durant
	South Oklahoma City Junior College	Oklahoma City
	Southwestern College	Oklahoma City
	Tulsa Junior College	Tulsa
	University of Oklahoma-Central Office	Norman

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	University of Oklahoma-Health Science Center	Oklahoma City
	University of Science and Arts of Oklahoma	Chickasha
	University of Tulsa	Tulsa
	Western Oklahoma State College	Altus
OR	Blue Mountain Community College	Pendleton
	Chemeketa Community College	Salem
	Clackamas Community College	Oregon City
	Clatsop Community College	Astoria
	Columbia Christian College	Portland
	Concordia College	Portland
	George Fox College	Newberg
	Judson Baptist College	Portland
	Lane Community College	Eugene
	Lewis and Clark College	Portland
	Linfield College	McMinnville
	Linn-Benton Community College	Albany
	Marylhurst Education Center	Marylhurst
	Mount Hood Community College	Gresham
	Multnomah School of the Bible	Portland
	Museum Art School	Portland
	Oregon State Higher Education District	
	Eastern Oregon State College	La Grande
	Oregon College of Education	Monmouth
	Oregon Institute of Technology	Klamath Falls
	Oregon State University	Corvallis
	Portland State University	Portland
	Southern Oregon State College	Ashland
	University of Oregon-Health Sciences Center	Portland
	Pacific University	Forest Grove
	Reed College	Portland
	Southwestern Oregon Community College	Coos Bay
	Treasure Valley Community College	Ontario
	Umpqua Community College	Rosenburg
	University of Portland	Portland
	Warner Pacific College	Portland
	Western Baptist Bible College	Salem
	Western Conservative Baptist Seminary	Portland
	Western Evangelical Seminary	Portland
	Williamette University	Salem
PA	Allegheny College	Meadville
	Allentown College of St. Francis De Sales	Center Valley
	Alliance College	Cambridge Springs
	Beaver College	Glenside
	Bloomsburg State College	Bloomsburg
	Bucks County Community College	Newton
	Butler County Community College	Butler
	Cabrini College	Radnor
	California State College	California
	Carlow College	Pittsburgh
	Carnegie-Mellon University	Pittsburgh
	Cedar Crest College	Allentown
	Chestnut Hill College	Philadelphia
	Cheyney State College	Cheyney
	Clarion State College	Clarion
	Community College of Allegheny County	Pittsburgh
	Community College of Beaver County	Monaca
	Community College of Philadelphia	Philadelphia
	Delaware Valley College of Science and Agriculture	Doylestown

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Dickinson College	Carlisle
	Drexel University	Philadelphia
	The Dropsie University	Philadelphia
	Duquesne University	Pittsburgh
	Eastern College	Saint Davids
	East Stroudsburg State College	East Stroudsburg
	Edinboro State College	Edinboro
	Franklin-Marshall College	Lancaster
	Gannon College	Erie
	Geneva College	Beaver Falls
	Gettysburg College	Gettysburg
	Gwynedd-Mercy College	Gwynedd Valley
	Harcum Junior College	Bryn Mawr
	Haverford College	Haverford
	Indiana University of Pennsylvania	Indiana
	Juniata College	Huntingdon
	Keystone Junior College	La Plume
	King's College	Wilkes-Barre
	Lafayette College	Easton
	La Roche College	Allison Park
	La Salle College	Philadelphia
	Lehigh University	Bethlehem
	Lincoln University	Lincoln University
	Lock Haven State College	Lock Haven
	Lycoming College	Williamsport
	Mansfield State College	Mansfield
	Marywood College	Scranton
	Mercyhurst College	Erie
	Millersville State College	Millersville
	Montgomery County Community College	Blue Bell
	Northeastern Christian Junior College	Villanova
	Pennsylvania State University	University Park
	Philadelphia College of Pharmacy and Science	Philadelphia
	Point Park College	Pittsburgh
	Reading Area Community College	Reading
	Saint Fidelis College	Herman
	Saint Francis College	Loretto
	Saint Joseph's College	Philadelphia
	Saint Vincent College	Latrobe
	Seton Hill College	Greensburg
	Slippery Rock State College	Slippery Rock
	Spring Garden College	Chestnut Hill
	Susquehanna University	Selinsgrove
	Swarthmore College	Swarthmore
	Temple University	Philadelphia
	University of Pennsylvania	Philadelphia
	University of Pittsburg	Pittsburgh
	University of Scranton	Scranton
	Ursinus College	Collegeville
	Villa Maria College	Erie
	Villanova University	Villanova
	Waynesburg College	Waynesburg
	West Chester State College	West Chester
	Westminster College	New Wilmington
	Widener College	Chester
	Wilkes College	Wilkes-Barre
	Williamsport Area Community College	Williamsport
	Wilson College	Chambersburg
PR	Inter American University of Puerto Rico	San German
	The Catholic University of Puerto Rico	Ponce
	University of Puerto Rico	Mayaguez
	University of Puerto Rico	Rio Pedras

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
RI	Brown University	Providence
	Providence College	Providence
	Roger Williams College	Bristol
	University of Rhode Island	Kingston
SC	Aiken Technical Education Center	Aiken
	Baptist College	Charleston
	Bob Jones University	Greenville
	Central Wesleyan College	Central
	Citadel Military College of South Carolina	Charleston
	Claflin College	Orangeburg
	Clemson University	Clemson
	Coastal Carolina College	Conway
	Coker College	Hartsville
	College of Charleston	Charleston
	Columbia College	Columbia
	Columbia Bible College	Columbia
	Converse College	Spartanburg
	Erskine College	Due West
	Florence-Darlington Technical College	Florence
	Francis Marion College	Florence
	Furman University	Greenville
	Greenville Technical College	Greenville
	Lander College	Greenwood
	Limestone College	Gaffney
	Morris College	Sumter
	Newberry College	Newberry
	North Greenville College	Tigerville
	Orangeburg-Calhoun Technical College	Orangeburg
	Piedmont Technical College	Greenwood
	South Carolina State College	Orangeburg
	Sumter Area Technical College	Sumter
	Tri County Technical College	Pendleton
	Trident Technical College	North Charleston
	University of South Carolina	Columbia
	University of South Carolina at Aiken	Aiken
	University of South Carolina at Beaufort	Beaufort
	University of South Carolina at Spartanburg	Spartanburg
	University of South Carolina at Union	Union
	Voorhees College	Denmark
	Winthrop College	Rock Hill
	Wofford College	Spartanburg
SD	Augustana College	Sioux Falls
	Black Hills State College	Spearfish
	Dakota Wesleyan University	Mitchell
	Freeman Junior College	Freeman
	National College of Business	Rapid City
	Northern State College	Aberdeen
	Presentation College	Aberdeen
	Sioux Falls College	Sioux Falls
	South Dakota School of Mines and Technology	Rapid City
	South Dakota State University	Brookings
	University of South Dakota-Springfield	Springfield
TN	Aquinas Junior College	Nashville
	Austin Peay State University	Clarksville
	Belmont College	Nashville
	Carson-Newman College	Jefferson City
	Chattanooga State Technical Community College	Chattanooga

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Christian Brothers College	Memphis
	Cleveland State Community College	Cleveland
	Columbia State Community College	Columbia
	Covenant College	Lookout Mountain
	Cumberland College	Lebanon
	David Lipscomb College	Nashville
	Dyersburg State Community College	Dyersburg
	East Tennessee State University	Johnson City
	Fisk University	Nashville
	Freed-Hardeman College	Henderson
	Free Will Baptist Bible College	Nashville
	George Peabody College for Teachers	Nashville
	Hiwassee College	Madisonville
	Jackson State Community College	Jackson
	King College	Bristol
	Knoxville College	Knoxville
	Lambuth College	Jackson
	LeMoyne-Owen College	Memphis
	Martin College	Pulaski
	Memphis State University	Memphis
	Middle Tennessee State University	Murfreesboro
	Milligan College	Milligan College
	Nashville State Technical Institute	Nashville
	Roane State Community College	Harriman
	Shelby State Community College	Memphis
	State Technical Institute at Memphis	Memphis
	Steed College	Johnson City
	Tennessee Technological University	Cookeville
	Tennessee Wesleyan College	Athens
	University of the South	Sewanee
	University of Tennessee	Knoxville
	University of Tennessee Center for Health Sciences	Memphis
	University of Tennessee at Martin	Martin
	University of Tennessee at Nashville	Nashville
	Vanderbilt University	Nashville
	Volunteer State Community College	Gallatin
	Walters State Community College	Morristown
TX	Abilene Christian University	Abilene
	Alvin Community College	Alvin
	Amarillo College	Amarillo
	American Technological University	Killeen
	Angelina College	Lufkin
	Angelo State University	San Angelo
	Austin College	Sherman
	Austin Presbyterian Technological Seminary	Austin
	Baylor College of Dentistry	Dallas
	Baylor College of Medicine	Houston
	Baylor University	Waco
	Bee County College	Beeville
	Blinn College	Brenham
	Brazosport College	Lake Jackson
	Cisco Junior College	Cisco
	Clarendon College	Clarendon
	College of the Mainland	Texas City
	Concordia Lutheran College	Austin
	Cooke County College	Gainesville
	Dallas Bible College	Dallas
	Dallas Christian College	Dallas
	Dallas County Community College District	
	Eastfield College	Mesquite
	El Centro College	Dallas
	Mountain View College	Dallas
	Richland College	Dallas

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Dallas Theological Seminary	Dallas
	Del Mar College	Corpus Christi
	DeVry Institute of Technology	Dallas
	East Texas Baptist College	Marshall
	East Texas State University	Commerce
	El Paso Community College	El Paso
	Frank Phillips College	Borger
	Galveston College	Galveston
	Grayson College	Denison
	Gulf Coast Bible College	Houston
	Hardin-Simmons University	Abilene
	Henderson County Junior College	Athens
	Houston Baptist University	Houston
	Houston Community College	Houston
	Howard College at Big Spring	Big Spring
	Howard Payne University	Brownwood
	Huston-Tillotson College	Austin
	Incarnate Word College	San Antonio
	Jacksonville College	Jacksonville
	Jarvis Christian College	Hawkins
	Kilgore College	Kilgore
	Lamar University	Beaumont
	Laredo Junior College	Laredo
	Lee College	Baytown
	Le Tourneau College	Longview
	Lon Morris College	Jacksonville
	Lubbock Christian College	Lubbock
	McLennan Community College	Waco
	McMurry College	Abilene
	Midland College	Midland
	Midwestern State University	Wichita Falls
	Navarro College	Corsicana
	North Harris County College	Houston
	North Texas State University	Denton
	Odessa College	Odessa
	Our Lady of the Lake University of San Antonio	San Antonio
	Pan American University	Edinburg
	Panola Junior College	Carthage
	Ranger Junior College	Ranger
	Rice University	Houston
	Saint Edward's University	Austin
	Sam Houston State University	Huntsville
	San Antonio College	San Antonio
	San Jacinto College	Pasadena
	Schreiner College	Kerrville
	Southern Bible College	Houston
	Southern Methodist University	Dallas
	South Plains College	Levelland
	South Texas College of Law	Houston
	Southwestern Assemblies of God College	Waxahachie
	Southwestern Baptist Theological Seminary	Fort Worth
	Southwestern Christian College	Terrell
	Southwestern Union College	Keene
	Southwestern University	Georgetown
	Southwest Texas State University	San Marcos
	Stephen F. Austin State University	Nacogdoches
	Tarleton State University	Stephenville
	Tarrant County Junior College-Northeast Campus	Hurst
	Tarrant County Junior College-Northwest Campus	Fort Worth
	Tarrant County Junior College-South Campus	Fort Worth
	Texarkana College	Texarkana
	Texas A & I University	Kingsville

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Texas A & I University-Corpus Christi	Corpus Christi
	Texas A & I University-Laredo	Laredo
	Texas A & M University-Main Campus	College Station
	Texas A & M University Moody College of Marine Sciences and Maritime Resources	Galveston
	Texas Christian University	Fort Worth
	Texas College	Tyler
	Texas Lutheran College	Seguin
	Texas Southmost College	Brownsville
	Texas State Technical Institute-James Connally Campus	Waco
	Texas State Technical Institute-Mid-Continent Campus	Amarillo
	Texas State Technical Institute-Rio Grande Campus	Harlingen
	Texas Tech University	Lubbock
	Texas Wesleyan College	Fort Worth
	Texas Woman's University	Denton
	Trinity University	San Antonio
	Tyler Junior College	Tyler
	University of Dallas	Irving
	University of Houston-Main Campus	Houston
	University of Houston-Clear Lake City	Houston
	University of Houston-Victoria Campus	Victoria
	University of Texas-Arlington	Arlington
	University of Texas-Austin	Austin
	University of Texas at Dallas	Richardson
	University of Texas-El Paso	El Paso
	University of Texas Health Science Center at Dallas	Dallas
	University of Texas Health Science Center at Houston	Houston
	University of Texas Medical Branch at Galveston	Galveston
	University of Texas-San Antonio	San Antonio
	Vernon Regional Junior College	Vernon
	Victoria College	Victoria
	Weatherford College	Weatherford
	Western Texas College	Snyder
	West Texas State Universtiy	Canyon
	Wharton County Junior College	Wharton
	Wiley College	Marshall
UT	Brigham Young University	Provo
	Stevens Henager College	Ogden
	University of Utah	Salt Lake City
	Utah Higher Education System Office	
	University of Utah	Salt Lake City
	Utah State University	Logan
	Southern Utah State College	Cedar City
	Weber State College	Ogden
	College of Eastern Utah	Price
	Dixie College	Saint George
	Snow College	Ephraim
	Utah Technical College at Salt Lake City	Salt Lake City
	Westminster College	Salt Lake City

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
VT	Champlain College	Burlington
	Johnson State College	Johnson
	Lyndon State College	Lyndonville
	Marlboro College	Marlboro
	Middlebury College	Middlebury
	Norwich University	Northfield
	Saint Michael's College	Winooski
	School for International Training	Brattleboro
	Southern Vermont College	Bennington
	Trinity College	Burlington
	University of Vermont and State Agriculture College	Burlington
	Vermont Institute of Community Involvement	South Burlington
	Vermont Technical College	Randolph Center
	Windham College	Putney
VA	Averett College	Danville
	Bridgewater College	Bridgewater
	College of William and Mary	Williamsburg
	Eastern Mennonite College	Harrisonburg
	Eastern Virginia Medical School	Norfolk
	Emory and Henry College	Emory
	Ferrum College	Ferrum
	Hampton Institute	Hampton
	Institute of Textile Technology	Charlottesville
	J. Sargeant Reynolds Community College	Richmond
	Madison University	Harrisonburg
	Old Dominion University	Norfolk
	Radford College	Radford
	Randolph-Macon College	Ashland
	Randolph-Macon Woman's College	Lynchburg
	Saint Paul's College	Lawrenceville
	University of Virginia	Charlottesville
	Virginia Intermont College	Bristol
	Virginia Military Institute	Lexington
	Virginia Polytechnic Institute and State University	Blacksburg
	Virginia Wesleyan College	Norfolk
	Washington and Lee University	Lexington
	Wytheville Community College	Wytheville
WA	Bellevue Community College	Bellevue
	Big Bend Community College	Moses Lake
	Centralia College	Centralia
	Central Washington State College	Ellensburg
	Clark College	Vancouver
	Columbia Basin Community College	Pasco
	Cornish School of Allied Arts	Seattle
	Eastern Washington State College	Cheney
	Evergreen State College	Olympia
	Fort Steilacoom Community College	Tacoma
	Fort Wright College of the Holy Names	Spokane
	Gonzaga University	Spokane
	Grays Harbor College	Aberdeen
	Green River Community College	Auburn
	Highline Community College	Midway
	Lower Columbia College	Longview
	Lutheran Bible Institute of Seattle	Seattle
	Northwest College of the Assemblies of God	Kirkland
	Olympia Technical Community College	Olympia
	Olympic College	Bremerton
	Pacific Lutheran University	Tacoma
	Peninsula College	Port Angeles

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Seattle Community College District	
	North Seattle Community College	Seattle
	Seattle Community College-Central Campus	Seattle
	Seattle Community College-South Campus	Seattle
	Seattle University	Seattle
	Shoreline Community College	Seattle
	Skagit Valley College	Mount Vernon
	Tacoma Community College	Tacoma
	University of Puget Sound	Tacoma
	Walla Walla College	College Place
	Walla Walla Community College	Walla Walla
	Washington State Community College-District 5	
	Edmonds Community College	Lynnwood
	Everett Community College	Everett
	Washington State Community College-District 17	
	Spokane Falls Community College	Spokane
	Washington State University	Pullman
	Wenatchee Valley College	Wenatchee
	Western Washington State College	Bellingham
	Whatcom Community College	Bellingham
	Whitman College	Walla Walla
	Whitworth College	Spokane
	Yakima Valley College	Yakima
WV	Alderson Broaddus College	Phillippi
	Beckley College	Beckley
	Bethany College	Bethany
	Bluefield State College	Bluefield
	Concord College	Athens
	Davis and Elkins College	Elkins
	Glenville State College	Glenville
	Marshall University	Huntington
	Morris Harvey College	Charleston
	Parkersburg Community College	Parkersburg
	Potomac State College	Keyser
	Salem College	Salem
	West Liberty State College	West Liberty
	West Virginia Institute of Technology	Montgomery
	West Virginia University	Morgantown
	Wheeling College	Wheeling
WI	Alverno College	Milwaukee
	Beloit College	Beloit
	Blackhawk Technical Institute	Janesville
	Cardinal Stritch College	Milwaukee
	Carroll College	Waukesha
	Carthage College	Kenosha
	Concordia College	Milwaukee
	District One Technical Institute	Eau Claire
	Edgewood College	Madison
	Fox Valley Technical Institute	Appleton
	Gateway Technical Institute	Kenosha
	Holy Redeemer College	Waterford
	Institute of Paper Chemistry	Appleton
	Lakeshore Technical Institute	Cleveland
	Lawrence University	Appleton
	Madison Area Technical College	Madison
	Madison Business College	Madison
	Marian College of Fond Du Lac	Fond Du Lac
	Marquette University	Milwaukee
	Mid-State Technical Institute	Wisconsin Rapids
	Milton College	Milton

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Milwaukee Area Technical College	Milwaukee
	Moraine Park Vocational, Technical and Adult Education Institute	Fond Du Lac
	Mount Mary College	Milwaukee
	Mount Senario College	Ladysmith
	Nicolet College and Technical Institute	Rhinelander
	North Central Technical Institute	Wausau
	Northeast Wisconsin Technical Institute	Green Bay
	Northland College	Ashland
	Ripon College	Ripon
	Saint Norbert College	De Pere
	Silver Lake College	Manitowoc
	Southwest Wisconsin Vocational-Technical Institute	Fennimore
	University of Wisconsin-Green Bay	Green Bay
	University of Wisconsin-Madison	Madison
	University of Wisconsin-Milwaukee	Milwaukee
	University of Wisconsin-System Office	Madison
	Viterbo College	La Crosse
	Waukesha County Technical Institute	Pewaukee
	Western Wisconsin Technical Institute	La Crosse
WY	Casper College	Casper
	Eastern Wyoming College	Torrington
	Laramie County Community College	Cheyenne
	Northwest Community College	Powell
	Sheridan College	Sheridan
	University of Wyoming	Laramie
	Western Wyoming Community College	Rock Springs